

Nelson Bay Evaluation Study for a Proposed Hatchery Salmon Remote Release, 2004

by

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May 2007

Alaska Department of Fish and Game

Divisions of Sport Fish and Commercial Fisheries



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Weights and measures (metric)		General		Measures (fisheries)	
centimeter	cm	Alaska Administrative		fork length	FL
deciliter	dL	Code	AAC	mid-eye-to-fork	MEF
gram	g	all commonly accepted		mid-eye-to-tail-fork	METF
hectare	ha	abbreviations	e.g., Mr., Mrs., AM, PM, etc.	standard length	SL
kilogram	kg			total length	TL
kilometer	km	all commonly accepted			
liter	L	professional titles	e.g., Dr., Ph.D., R.N., etc.	Mathematics, statistics	
meter	m			<i>all standard mathematical</i>	
milliliter	mL	at	@	<i>signs, symbols and</i>	
millimeter	mm	compass directions:		<i>abbreviations</i>	
		east	E	alternate hypothesis	H _A
		north	N	base of natural logarithm	<i>e</i>
		south	S	catch per unit effort	CPUE
		west	W	coefficient of variation	CV
		copyright	©	common test statistics	(F, t, χ^2 , etc.)
		corporate suffixes:		confidence interval	CI
		Company	Co.	correlation coefficient	
		Corporation	Corp.	(multiple)	R
		Incorporated	Inc.	correlation coefficient	
		Limited	Ltd.	(simple)	r
		District of Columbia	D.C.	covariance	cov
		et alii (and others)	et al.	degree (angular)	°
		et cetera (and so forth)	etc.	degrees of freedom	df
		exempli gratia		expected value	<i>E</i>
		(for example)	e.g.	greater than	>
		Federal Information		greater than or equal to	≥
		Code	FIC	harvest per unit effort	HPUE
		id est (that is)	i.e.	less than	<
		latitude or longitude	lat. or long.	less than or equal to	≤
		monetary symbols		logarithm (natural)	ln
		(U.S.)	\$, ¢	logarithm (base 10)	log
		months (tables and		logarithm (specify base)	log ₂ , etc.
		figures): first three		minute (angular)	'
		letters	Jan,...,Dec	not significant	NS
		registered trademark	®	null hypothesis	H ₀
		trademark	™	percent	%
		United States		probability	P
		(adjective)	U.S.	probability of a type I error	
		United States of		(rejection of the null	
		America (noun)	USA	hypothesis when true)	α
		U.S.C.	United States	probability of a type II error	
			Code	(acceptance of the null	
		U.S. state	use two-letter	hypothesis when false)	β
			abbreviations	second (angular)	"
			(e.g., AK, WA)	standard deviation	SD
				standard error	SE
				variance	
				population	Var
				sample	var
Weights and measures (English)					
cubic feet per second	ft ³ /s				
foot	ft				
gallon	gal				
inch	in				
mile	mi				
nautical mile	nmi				
ounce	oz				
pound	lb				
quart	qt				
yard	yd				
Time and temperature					
day	d				
degrees Celsius	°C				
degrees Fahrenheit	°F				
degrees kelvin	K				
hour	h				
minute	min				
second	s				
Physics and chemistry					
all atomic symbols					
alternating current	AC				
ampere	A				
calorie	cal				
direct current	DC				
hertz	Hz				
horsepower	hp				
hydrogen ion activity	pH				
(negative log of)					
parts per million	ppm				
parts per thousand	ppt, ‰				
volts	V				
watts	W				

FISHERY DATA SERIES NO. 07-29

**NELSON BAY EVALUATION STUDY FOR A PROPOSED HATCHERY
SALMON REMOTE RELEASE, 2004**

by

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May 2007

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This document should be cited as:

Kampshoff, M. C., R. A. Merizon, and S. D. Moffitt. 2007. Nelson Bay evaluation study for a proposed hatchery salmon remote release, 2004. Alaska Department of Fish and Game, Fishery Data Series No. 07-29, Anchorage.

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ABSTRACT

In 2003, Prince William Sound Aquaculture Corporation (PWSAC) proposed a remote release of hatchery salmon in Nelson Bay, Prince William Sound. After a review of the Prince William Sound – Copper River Phase 3 Comprehensive Salmon Plan in 2003, Alaska Department of Fish and Game and PWSAC embarked on a three part study to evaluate the abundance and distribution of wild salmon stocks in Nelson Bay. Evaluation projects included a purse seine test fishery with 8 sample locations, a stream inventory program including ground based and aerial surveys. Fieldwork commenced during the first week of June and continued through 24 September 2004. Pink salmon *Onchorynchus gorbuscha* were the predominant species observed during the ground surveys (99% based on peak counts). The majority of salmon escapement occurred in 3 of the 12 ground surveyed streams (Humpback Creek, Deep Creek, and the unnamed stream 10155). Aerial survey results reflected a similar trend as the ground surveys. All 5 species of Pacific salmon were caught in the test fishery and pink salmon were the predominant species. The largest salmon catches occurred at the Bomb Point, north Hawkins Island, Channel Islands, and Salmo Point sites. These data will improve the understanding of the dynamic ecosystem of Nelson Bay for fishery managers, biologists, the scientific community, and the interested public. However, additional fieldwork must be completed to develop a more reliable database of escapement timing, catch timing, interception points, straying rates of existing hatchery stocks, and stock size estimates within Nelson Bay.

Key words: Nelson Bay, Prince William Sound, sockeye salmon, coho salmon, pink salmon, chum salmon, anadromous, purse seine test fishery, stream surveys, aerial surveys, otoliths, hatchery salmon, remote releases, Prince William Sound – Copper River Phase 3 Comprehensive Salmon Plan.

INTRODUCTION

In 2003, Prince William Sound Aquaculture Corporation (PWSAC) proposed a remote release of chum salmon *Oncorhynchus keta* in Nelson Bay, Prince William Sound (PWS; Figure 1) using their existing chum salmon broodstock from Wally Noerenberg Hatchery (WNH). PWSAC indicated the proposed Nelson Bay remote release of hatchery salmon would 1) provide a local commercial fishery, 2) provide fresher product for local processors, and 3) increase the areas in PWS for commercial purse seine fishing gear. Nelson Bay was one of the 22 sites reviewed in the early 1990s for the Prince William Sound – Copper River Phase 3 Comprehensive Salmon Plan (PWS RPT 1994). The Phase 3 Plan was, as noted inside the front cover, “...released by the Prince William Sound/Copper River Regional Planning Team as part of the cooperative fisheries planning process between the Alaska Department of Fish and Game and the Prince William Sound Aquaculture Corporation...” Appendix 5 in the Phase 3 plan is the overview of the remote release site evaluations and recommendations. More details of the remote release site evaluations and recommendations are in the PWS/CR RPT Remote Release Site Report (PWS RPT 1993).

The proposal to conduct a remote release of WNH chum salmon in Nelson Bay was reviewed by the Alaska Department of Fish and Game (ADF&G) in the summer and fall of 2003. The WNH chum salmon broodstock originated from Wells River (Northern District) and Beartrap Creek (Eastern District: PWS RPT 1994). The Phase 3 Plan recommended Nelson Bay as a possible remote release site for early chum salmon or sockeye salmon *O. nerka*; however, it also recommended that a local broodstock, such as chum salmon from Koppen Creek (Sheep Bay), be developed. The preliminary conclusion of ADF&G was that the WNH stock of chum salmon would not be considered a local stock for a remote release in Nelson Bay. Subsequently, PWSAC decided to expand the species they would consider for remote release in Nelson Bay to chum, sockeye, or coho *O. kisutch* salmon.

The Phase 3 Plan recommends a series of evaluation studies prior to any remote release of hatchery salmon within PWS. There are six different evaluation studies the Phase 3 Plan states may be required to “evaluate the effects of remote release programs on wild stocks” (PWS RPT 1994). The Nelson Bay evaluation project includes three of those recommended studies: 1) a purse seine test fishery, 2) a ground survey inventory of existing wild stock salmon, and 3) an aerial survey inventory of existing wild stock salmon.

Fieldwork began during the first week of June and continued through 24 September, 2004. The extended field season was to encompass the run timing of all area wild stock salmon that may be impacted by a release of hatchery salmon. The ground surveys began on 7 June and continued once a week through 17 September, 2004. The aerial surveys began on 25 June and continued approximately once a week through 24 September, 2004. The test fishery began on 6 June and continued twice weekly through 15 September, 2004.

STUDY AREA

The study area encompasses waters east of the longitude of Bomb Point (145° 54.068' W) and north of the latitude of Orca Adventure Lodge (60° 34.8' N) including Nelson Bay (Figure 1). The study area is characterized as a glacially carved fjord with large tidal fluctuations. The water depths range from 5.5-18.5 m at the head of Nelson Bay to over 192 m near Bomb Point. There are nineteen documented anadromous streams (including the Rude River main stem and six upper Rude River streams; Figure 1) in the study area (ADF&G 1998). Turbidity and water temperature in Nelson Bay are largely controlled by output from the Rude River. This river is a large, glacially turbid system with potentially incomplete anadromous fish documentation. Statistical areas 221-10 and 228-10, which include the study area and proposed hatchery salmon release location, have been closed to commercial fishing since 1968 (5AAC 24.350(3)(a)).

The study area for the ground and aerial survey stream inventory components include streams of Orca Inlet east of Bomb Point and north of the latitude of Orca Adventure Lodge (60° 34.8' N), including Nelson Bay, the Rude River, and Deep Bay. Currently only one stream (Humpback Creek) in this study area is routinely surveyed as part of the Eastern District aerial surveys.

The study area for the test fishery component included waters east of Bomb Point, Nelson Bay, and within Orca Inlet north of the latitude of Orca Adventure Lodge (60° 34.8' N). The area south of Observation Island may be too shallow for a commercial purse seine fishery; however, fish from a remote release in Nelson Bay may mill in this area.

METHODS

GROUND SURVEY

Watershed Delineation

To quantify stream morphology and distribution of salmon, the streams were delineated into zones. To begin, the 3.7 m (12 ft) tide line was used to distinguish intertidal and upstream zones. The 3.7 m tide line was marked using a Kern GK0-A survey level¹, survey tripod, and a staff

¹ Product names used in this report are included for scientific completeness, but do not constitute product endorsement by the Alaska Department of Fish and Game.

meter adjustable to 10.8 m. The stage of the tide was found by using a tide table for Cordova, Alaska. Surveys were completed at low tide where the tide level ranged from -0.83 m to +0.89 m. The staff meter was set according to tidal stage and held at the edge of the water adjacent to the mouth of the stream. The tripod mounted survey level was placed upstream to locate the 3.7 m tidal stage. This location was marked using plastic flagging. On streams with an expansive intertidal zone, several readings were taken (Humpback Creek and Deep Creek). Hand drawn maps and photos of each identified stream are in Appendix A1–A21.

Within each zone (intertidal and upstream), the stream was marked into sections to more accurately quantify stream morphology and the extent of use by spawning salmon. Sections were delineated by primary morphologic characteristics (main channel versus side channel, change in gradient, or change in substrate). Sections were measured for both length and average width to estimate available spawning area (m²) for each stream. An estimate of available spawning area (ASA) was calculated for streams surveyed by foot. Estimates were calculated as:

$$\text{Stream ASA (m}^2\text{)} = \Sigma(l * w * g) \quad (1)$$

Where l is the length of the survey section (m), w is the average width of the survey section (m), and g is the percent of gravel within a given section.

Habitat Survey

Habitat data were collected for each stream section in mid June, 2004. These data included estimated percentage of substrate type, percentage of riparian cover, count of woody debris, and presence and location of passage barriers. From these data, an estimate of available spawning habitat was calculated.

Abundance and Distribution Survey

In 2004, PWSAC provided a 5.5 m, aluminum Grayling skiff with a 40 hp Suzuki outboard. This skiff was used for transporting a 2-person crew, sampling gear, and safety equipment to the identified stream mouths (Figure 1). In 2004, it was only possible to visit each identified stream once a week due to the large study area and speed of the skiff; the original study plan called for twice weekly surveys. The skiff was anchored off the mouth of each stream and, depending on tidal stage, surveys were conducted from the lowest section in the intertidal zone to the upstream extent of fish use or known passage barrier. Crews carried necessary safety gear with them including food, survival suits, first-aid kit, a radio, and bear protection.

Survey crews collected data including the survey date, time of day, stream name and number, surveyors' names, weather conditions, tide stage, and number of live and dead fish by species for each section. Fish identification was aided by the use of polarized glasses. Escapement timing figures for each identified stream are in Appendix A22.

Prospecting Undocumented Spawning Locations

On 25 May, 2004, a reconnaissance flight was made by ADF&G staff to identify cataloged anadromous streams and streams that had no documented anadromous fish use. This flight was not used as an escapement estimation survey. During the first week of ground surveys to known anadromous streams in early June, the undocumented streams were visited to identify location and potential spawning habitat. These streams were visited periodically throughout July and

August to document any spawning activity. Documentation of anadromous streams with spawning salmon was provided to the ADF&G Sport Fish Division for update of the southcentral Alaska Anadromous Stream Catalog (ADF&G 1998).

Scheduling and Timing

Only twelve (excluding the Rude River mainstem, six upper Rude River systems, and the unnamed stream 10160-2011) of the nineteen total anadromous streams in the study area, identified in the ADF&G Anadromous Stream Catalog, were surveyed once a week from 7 June through 17 September, 2004. However, the unnamed stream 10160-2011 was surveyed once on 6 August. This covered the return timing of possible runs of enhanced sockeye, chum, pink *O. gorbuscha*, and coho salmon. Conducting ground surveys on the six upper Rude River streams and the unnamed stream 10160-2011 proved to be problematic (see *Upper Rude River Surveys*). In 2004, a two-person crew was successful in surveying all of the streams in two to three full days.

Upper Rude River Surveys

On 6 August, 2004, ADF&G assessed the likelihood of using ground surveys for the six known anadromous streams in the upper Rude River and the unnamed stream 10160-2011. The ADF&G Sport Fishery Division 5 m, Alaska Airboat, 7000 Series airboat was used to access the north fork of the Rude River; the 18 m, Marco, research vessel *Solstice* was used as a transport vessel from the Cordova boat harbor to the mouth of the Rude River. From the mouth of the Rude River the airboat was deployed to navigate the Rude River. ADF&G was only able to visit the unnamed stream 10160-2011. A single ground survey was performed on this stream and was not inventoried by foot surveys again throughout 2004.

The ability to survey the streams in the upper Rude River by airboat was limited because the *R/V Solstice* and the airboat had other field obligations. Second, a sufficient water level in the upper Rude River was required to maneuver the airboat. Due to an unseasonably dry summer, high water velocities due to glacial melt, and woody debris obscuring the numerous braided channels, the upper Rude River proved to be unnavigable with an airboat or jet drive skiff. Therefore, aerial surveys were used exclusively to inventory the upper Rude River streams.

AERIAL SURVEYS

Scheduling, Timing and Data Collection

Surveys were flown in a PA-12, single-engine, fixed-wing floatplane. The twelve streams inventoried by ground surveys plus the unnamed stream 10160-2011 were flown once a week during the normally scheduled Eastern or Southeastern District aerial survey flights from 25 June through 24 September, 2004. The six anadromous streams on the north fork of the Rude River were surveyed from 11 August through 24 September, 2004. The six upper Rude River streams were not surveyed until August to minimize expense and take advantage of traditional coho salmon run timing. Data collected included stream name and number; weather and survey conditions; and number of live fish by species and location (bay, mouth, and stream).

Escapement estimates were calculated using two different methods: 1) area under the curve calculations (Pirtle 1977), and 2) peak seasonal survey counts. Accuracy of escapement estimates based on aerial surveys depend on the number of observations made and their distribution throughout the run; the accuracy of counts (observer efficiency), and the amount of

time salmon entering the survey area were visible to observers (stream life) (Bue et al. 1998). Stream life in Prince William Sound is highly variable (Bue et al. 1998); however, we used a fixed estimate of 17.5 days (Helle et al. 1964).

TEST FISHERY

Purse Seining and Equipment

The contracted commercial purse seine vessel *F/V Rafferty*, a 15.4 m, Hoquiam Boatworks purse seine vessel, was used to conduct the Nelson Bay test fishery in 2004. This contract included adequate personnel to complete the fishing, safety equipment, and purse seine. A 274 m (150 fathom) commercial, regulation size, purse seine was used to collect samples at eight sample locations.

Only one ADF&G crewmember was required on each sampling trip. ADF&G equipment used in the test fishery included survival suits, otolith sampling kit, dip net, one large tote (to hold samples) and polarized glasses. The otolith sampling kit included a clipboard with data sheets, map, otolith trays, knife, and tweezers. Personal gear taken onboard the vessel included raingear, rubber gloves, and rubber boots.

Sampling took approximately 45 to 60 minutes per sample location. Sets were held for 20 minutes. Depending on the number of sample locations, a typical sampling day would last approximately 7 to 10 hours.

Data Collection and Otolith Recovery

ADF&G technicians were responsible for collecting the sample date, sample site name and number, latitude and longitude for each set, duration of set (including start time, full deploy, hold time, start retrieve, and purse time), direction of set opening, bottom depth (minimum and maximum), tide stage and height, weather conditions, current direction, number of Pacific salmon by species and set, and a sample of otoliths by location by week. With the exception of fish collected for otolith recovery all fish were released after catch size estimates were made. Figures with total catch and catch timing by sample location are in Appendix B.

The number of otoliths collected depended on the test fishery catch by species. If the total catch in a set exceeded 100 salmon by species, otoliths were collected from approximately 20% of the catch. Otoliths were only collected from pink and chum salmon because of the small catches of sockeye and coho salmon. The majority of recovered otoliths were from pink salmon due to their predominance in the test fishery.

Schedule and Timing

Four to eight test fish sites (Figure 1) were sampled twice weekly from 6 June to 15 September. This covered the timing of the possible enhanced stocks of sockeye, chum, and coho salmon. In 2004, test fishing days were scheduled on Wednesdays and Sundays to stagger the sampling days evenly through the week. The crew of the *F/V Rafferty* also participated in the 2004 Commercial Common Property Fishery (CPF), occasionally delaying sampling by a day.

RESULTS

GROUND SURVEYS

Ground surveys began on 7 June and continued once a week through 17 September. A crew of two technicians was able to survey all twelve documented streams (excluding the Rude River and systems within the Rude River drainage) in the study area in approximately two to three days. Stream delineation was completed upon the first visit to each stream. Delineation began from the 3.7 m tideline and continued upstream to a passage barrier. Passage barriers were present on six of the twelve streams (Table 1). The majority of the substrate among all sections was gravel for eight of the twelve streams ($\geq 58\%$). The number of sections per stream ranged from one to eleven. The majority of the streams were divided into at least six survey sections (Table 1).

The survey crew observed a peak escapement of 22,947 pink, 68 chum, 101 coho, and 10 sockeye salmon among the twelve surveyed streams in the Nelson Bay study area (Table 2). The highest abundances of salmon occurred in the following streams: pink salmon in Humpback Creek, chum salmon in the unnamed tributary (10160-2011) of the Rude River (from one visit on 6 August), and coho salmon in the unnamed stream 10165. Spawning pink salmon were present in ten of the twelve streams inventoried by ground surveys. Spawning chum salmon were present in five and coho salmon in one of the streams inventoried by ground surveys. Within the study area, pink salmon escapement was documented from 12 July to 13 September and the mean escapement date was 12 August (Table 3; Figure 2). Chum salmon escapement was documented from 27 July to 17 September and the mean escapement date was 6 August (Table 4; Figure 2). Coho salmon were only observed on 23 and 31 August in the unnamed stream 10165 (Table 5). Similarly, sockeye salmon were only observed on 3, 9, and 17 September in the unnamed stream 10155 (Table 6).

The majority of salmon escapement occurred in three of the streams inventoried by ground surveys (Table 2; Figure 3). Humpback Creek, Deep Creek, and the unnamed stream (10155) on the east side of the Rude River delta contributed 83.9% (based on peak daily counts) of all salmon escapements in the Nelson Bay study area. Among all streams, pink salmon contributed 99% of the observed salmon escapement in the Nelson Bay study area. Based on peak daily counts, Humpback Creek contributed 67% of the total pink escapement in the study area.

The survey crew observed spawning chum, coho, and sockeye salmon in streams where spawning had not been documented prior to this study (Table 7). Within the study area, chum salmon were observed spawning in five and sockeye salmon in one stream where they were not known to spawn. Juvenile coho salmon were observed in four streams where they were not known to rear (Table 7). These data were submitted to the ADF&G Sport Fish Division for addition into the State of Alaska Anadromous Stream Catalog.

Aerial surveys were the most effective means to survey the documented anadromous streams on the upper Rude River (see *METHODS – Ground Surveys*).

Humpback Creek accounted for nearly 40% of the total ASA (approximately 6,277 m² of spawning area; Table 8) for all streams where habitat data were recorded (n=9). These data correlated well with peak count escapement estimates for pink salmon ($r^2=0.97$; Figure 4). Using ASA data collected in 2004, we estimated the maximum wild stock production for pink salmon. The estimate does not take into account actual observed escapements. Assuming an average of

1.1m² per spawner (McNeil 1967 and Enuitina 1972), an average fecundity (eggs/female) of 1,822 (Helle et al. 1964 and Helle 1970), and an average freshwater survival of 4.3% (Taylor 1983), an estimated average of 1.2 million pink salmon fry could be produced in the nine streams where an ASA estimate was calculated (Table 9).

AERIAL SURVEYS

For the twelve streams in Nelson Bay and the unnamed tributary of the Rude River (10160-2011), aerial surveys began on 25 June and continued approximately once a week until 24 September (12 surveys). Surveys were completed as part of the regularly scheduled Eastern District and Southeastern District aerial surveys for inseason management of the PWS purse seine fishery. Survey flights for the Nelson Bay study area streams were completed in approximately one hour.

As a result of difficulties conducting ground surveys in the upper Rude River (see *METHODS – Ground Surveys*) aerial surveys were used to estimate escapement in this portion of the study area. The six cataloged streams on the north fork of the Rude River were flown along with the existing Eastern District aerial survey route four times from 11 August through 24 September, 2004.

Aerial surveys documented a peak escapement estimate for all streams in the study area of 12,710 pink, 326 chum, and 5 coho salmon (Table 10). No sockeye salmon were observed during aerial surveys in 2004. The highest abundance of both pink and chum salmon were observed in Humpback Creek, and the highest abundance of coho salmon was observed in the unnamed stream in the north fork of the Rude River (10160-2175; Table 10). Pink salmon were observed in nine of the nineteen streams inventoried by aerial surveys (Table 10). Chum salmon were observed in five and coho salmon in one of the nineteen streams inventoried by aerial surveys (Table 10).

Aerial and ground survey daily peak count estimates of pink salmon escapement correlated well ($r^2=0.833$; $n=144$) in 2004 (Figure 5). Only five daily observations, all in Humpback Creek, exceeded 3,000 pink salmon.

TEST FISHERY

A purse seine test fishery began on 6 June and continued twice weekly through 15 September (29 total survey days). In June and July, sample sites were fished on a rotating schedule. The four western most sites (including Bomb Point, north Hawkins Island, Salmo Point, and Channel Islands) were fished one day of the week and the six eastern most sites (including Salmo Point and Channel Islands) were fished the second day of the week. In August and September, an attempt was made to fish every site, twice a week due to high catches of pink salmon.

The majority of the salmon caught in the test fishery were pink salmon (82%; Table 11). Chum salmon contributed 8%, coho salmon 9%, and sockeye salmon 1% to the total test fishery catch (Table 11). The largest catches of pink and chum salmon occurred at the north Hawkins Island sample site, and the largest catches of coho salmon occurred at the Channel Islands sample site (Table 11). The majority of salmon were caught in the four western most sample sites (95.7% of pink salmon, 80.1% of chum salmon, 68.3% of coho salmon and 72.4% of sockeye salmon; Figure 6). Only 5 Chinook salmon *O. tshawytscha* were caught between the Shepherd Point, NE Nelson Bay, Channel Islands, and Bomb Point sites from 6 June through 1 August.

Peak salmon catch timing was highly variable depending on the species. At the north Hawkins Island site, peak catch per set was highest for pink salmon (500 on 1 August; Table 12) and chum salmon (50 on 25 July; Table 13). Coho salmon peak catch per set was highest at the Channel Islands site (62 on 25 August; Table 14). Sockeye salmon peak catch per set occurred at the three western most (sites 1–3) sample locations (Table 15).

Catch timing within the Nelson Bay study area varied by species. Pink salmon catches occurred from 27 June to 8 September and the mean catch date was 1 August (Table 12). Chum salmon catches occurred from 6 June to 25 August and the mean catch date was 15 July (Table 13). Coho salmon catches occurred from 30 June to 15 September (the last day of the test fishery). The mean catch date for coho salmon was 22 August (Table 14).

The test fishery was able to collect basic bathymetric and water temperature data during the 2004 season. Depths ranged from approximately 141 m at Bomb Point to only 19 m at the head of Nelson Bay (Figure 7). Average water temperatures ranged from 7.5 °C in early June to 16 °C in mid-August (Figure 8).

Other than Pacific salmon, six non-salmon marine fish species were caught in the test fishery during 2004 (Figure 9). Of the test fishery bycatch, approximately 95% were starry flounder *Platichthys stellatus*. Over 45% of all bycatch from the test fishery occurred at the NE and NW Nelson Bay sample sites (all starry flounder). A total of six salmon sharks *Lamna ditropis* were caught at the north Hawkins Island sample site.

From 15 July to 11 August, 499 pairs of otoliths were recovered from pink and chum salmon caught in the test fishery (Table 16). A total of 3,073 salmon were caught in sets from which otoliths were recovered. Otoliths were recovered from the five western most sample locations (sites 1-5). From the 499 otolith pairs (pink and chum salmon) recovered, nineteen were of hatchery origin. The largest portion of those came from pink salmon (7% of otoliths recovered on 15 July, and 1% of otoliths recovered on 1 August) from the Solomon Gulch Hatchery facility run by the Valdez Fisheries Development Association (VFDA) in the Port of Valdez. On 21 July, one chum salmon from the WNH operated by the PWSAC was recovered in the test fishery.

DISCUSSION

The Nelson Bay study area (statistical areas 228-10 and 221-10) has been closed to commercial fishing since 1968. ADF&G has collected very limited data on salmon abundance and distribution in this area. Data collected in 2004 provides a better understanding of the salmon abundance and distribution in Nelson Bay. As a result of ground surveys, chum, coho, and sockeye salmon were observed in streams where they were previously undocumented. Relatively small wild stock populations occurred in most streams surveyed (10 of the 12 surveyed streams had peak daily counts <1,800 salmon). These stocks may become vulnerable to a commercial fishery or straying hatchery salmon.

Additional data will be critical to better understanding the escapement timing and local abundance of these stocks. Specifically, collecting data from an odd-brood year pink salmon return is imperative to understanding specific brood year abundance and escapement timing. A second year of data collection will improve escapement timing curves, catch timing, catch distribution by location and species, and stock abundance (by brood year for pink salmon).

ACKNOWLEDGMENTS

The authors gratefully acknowledge the following individuals for their many contributions that were essential to the success of this project and the completion of his report. PWSAC provided the majority of the funding for this study and provided needed input in making this project successful. The following permanent ADF&G staff contributed to the many planning sessions and fieldwork: D. Ashe, D. Branshaw, D. Gray, L. Laird, B. Lewis and B. Marston. The following seasonal ADF&G staff contributed to long days of fieldwork, inseason management of the project, and thermally marked otolith interpretation: J. Allen, A. Lindsley, L. Padawer, E. Quilty and H. Slazak. Finally, thank you to R. Jensen and the crew of the *F/V Rafferty*.

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TABLES AND FIGURES

Table 1.—Stream habitat and morphology data collected during the Nelson Bay evaluation study, 2004.

Stream		Tide Zone	Section	Percent Substrate by location					Percent Riparian Cover	Pieces Woody Debris	Barrier (Y / N)
Name	Number			Silt	Sand	Gravel	Cobble	Boulders			
L. Humpback	221-10-10100	Tidal	A	0	5	35	60	0	50	1	N
L. Humpback	221-10-10100	Tidal	B	0	5	60	35	0	100	2	N
L. Humpback	221-10-10100	Upstream	A	0	5	60	20	10	100	4	N
L. Humpback	221-10-10100	Upstream	B	0	5	40	35	20	100	8	N
L. Humpback	221-10-10100	Upstream	C	0	5	35	20	45	100	15	N
L. Humpback	221-10-10100	Upstream	D	0	0	0	15	85	100	6	Y
Humpback	221-10-10110	Tidal	B	0	5	80	15	0	0	4	N
Humpback	221-10-10110	Tidal	A	0	5	80	15	0	20	0	N
Humpback	221-10-10110	Upstream	A	0	5	60	35	0	100	1	N
Humpback	221-10-10110	Upstream	B	0	5	60	35	0	100	1	N
Humpback	221-10-10110	Upstream	C	0	10	40	45	5	100	3	N
Humpback	221-10-10110	Upstream	D	0	10	50	35	5	100	12	N
Humpback	221-10-10110	Upstream	E	0	5	40	50	5	100	0	N
Humpback	221-10-10110	Upstream	F	0	10	65	15	10	100	1	N
Humpback	221-10-10110	Upstream	G	0	25	20	20	35	100	5	N
Humpback	221-10-10110	Upstream	H	0	5	80	10	5	100	4	N
Unknown	221-10-10130	Tidal		0	5	75	20	0	0	0	N
Unknown	221-10-10130	Tidal		0	5	75	20	0	0	6	N
Unknown	221-10-10130	Tidal		0	5	80	15	0	100	4	N
Unknown	221-10-10130	Upstream	A	0	10	50	30	10	100	4	N
Unknown	221-10-10130	Upstream	B	0	10	30	40	20	40	6	N
Unknown	221-10-10130	Upstream	C	0	30	40	15	15	0	1	Y
Unknown	221-10-10140	Tidal		10	10	70	10	0	0	2	N
Unknown	221-10-10140	Tidal		10	10	70	10	0	0	3	N
Unknown	221-10-10140	Tidal		10	10	70	10	0	35	6	N
Unknown	221-10-10140	Tidal		0	15	75	10	0	50	3	N
Unknown	221-10-10140	Upstream	A	0	5	40	35	0	50	3	N
Unknown	221-10-10140	Upstream	B	0	10	80	10	0	50	2	N
Unknown	221-10-10140	Upstream	C	0	5	65	25	5	100	3	N
Unknown	221-10-10140	Upstream	D	0	5	80	15	0	100	1	N
Unknown	221-10-10140	Upstream	E	0	5	80	10	5	100	1	N
Unknown	221-10-10140	Upstream	F	0	5	25	55	15	100	5	N

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Table 1.–Page 2 of 2.

Stream		Tide Zone	Section	Percent Substrate by location					Percent Riparian Cover	Pieces Woody Debris	Barrier (Y / N)
Name	Number			Silt	Sand	Gravel	Cobble	Boulders			
Unknown	221-10-10140	Upstream	G	0	5	50	35	10	0	0	Y
Unknown	221-10-10155	Tidal		75	15	10	0	0	0	0	N
Unknown	221-10-10155	Tidal		60	15	25	0	0	100	0	N
Unknown	221-10-10155	Tidal		10	15	65	10	0	100	0	N
Unknown	221-10-10155	Tidal		0	15	75	10	0	100	0	N
Unknown	221-10-10155	Upstream	A	0	10	85	5	0	100	0	N
Unknown	221-10-10155	Upstream	B	0	10	85	5	0	100	5	N
Unknown	221-10-10155	Upstream	C	0	10	85	5	0	100	5	N
Unknown	221-10-10155	Upstream	D	0	10	85	5	0	100	15+	N
Unknown	221-10-10165		Not surveyed								
Rob. Falls	221-10-10170	Tidal	C	70	10	20	0	0	0	0	N
Rob. Falls	221-10-10170	Tidal	B	30	5	65	0	0	100	0	N
Rob. Falls	221-10-10170	Tidal	A	0	5	85	10	0	100	0	N
Rob. Falls	221-10-10170	Upstream	A	0	5	85	10	0	100	0	N
Rob. Falls	221-10-10170	Upstream	B	0	5	80	15	0	100	2	N
Rob. Falls	221-10-10170	Upstream	C	0	5	65	30	0	100	4	N
Rob. Falls	221-10-10170	Upstream	D	0	5	50	40	5	100	10+	N
Rob. Falls	221-10-10170	Upstream	E	0	10	50	25	15	100	10+	Y
Unknown	10170-2004	Upstream	A	0	5	65	25	5	100	10+	N
Unknown	221-10-10173	Tidal	C	100	0	0	0	0	0	0	N
Unknown	221-10-10173	Tidal	B	25	5	60	10	0	100	0	N
Unknown	221-10-10173	Tidal	A	10	5	60	20	5	100	0	N
Unknown	221-10-10173	Upstream	A	0	5	40	40	15	100	2	N
Unknown	221-10-10173	Upstream	B	0	5	20	25	50	100	5	N
Unknown	221-10-10173	Upstream	C	0	5	30	30	35	100	12	Y
Unknown	228-10-18640	Tidal	A	0	5	70	15	10	50	0	N
Unknown	228-10-18640	Upstream	A	0	5	55	15	25	100	2	Y
Deep Ck.	228-10-18650	Tidal	C	0	0	85	15	0	25	0	N
Deep Ck.	228-10-18650	Tidal	B	0	0	85	15	0	25	0	N
Deep Ck.	228-10-18650	Tidal	A	0	0	85	15	0	100	2	N
Deep Ck.	228-10-18650	Upstream	A	0	0	75	20	5	100	2	N
Deep Ck.	228-10-18650	Upstream	B	0	0	65	25	10	100	5	N
Deep Ck.	228-10-18650	Upstream	C	0	0	65	25	10	100	3	N
Deep Ck.	228-10-18650	Upstream	D	0	0	35	25	40	100	10+	N

Table 2.—Escapement estimation using peak counts and area under the curve (AUC) for pink, chum, coho and sockeye salmon from ground surveyed streams within the Nelson Bay area, 2004.

Stream			Peak Counts					AUC	
			Pink	Chum	Coho	Sockeye	Percent of	Pink	Percent of
Number	Name	Region					Total		Total
221-10-10100	Little Humpback	N. Orca Inlet	672	0	0	0	2.9%	866	2.9%
221-10-10110	Humpback Cr.	N. Orca Inlet	15,325	9	0	0	66.3%	19,800	67.2%
221-10-10130	Unknown	N. of Shepherd Pt.	705	0	0	0	3.0%	655	2.2%
221-10-10140	Unknown	NE Nelson Bay	91	0	0	0	0.4%	304	1.0%
221-10-10155	Unknown	E. Rude River delta	2,300	5	0	10	10.0%	2,242	7.6%
221-10-10165	Unknown	W. Rude River delta	0	0	101	0	0.4%	2	0.0%
221-10-10170	Robinson Falls Cr.	NW Nelson Bay	1,069	2	0	0	4.6%	1,490	5.1%
221-10-10170-2004	Unknown	NW Nelson Bay	0	0	0	0	0.0%	0	0.0%
221-10-10173	Unknown	NW Nelson Bay	2	0	0	0	0.0%	1	0.0%
228-10-18640	Unknown	N. Hawkins Isl.	1,000	0	0	0	4.3%	1,816	6.2%
228-10-18650	Deep Cr.	N. Hawkins Isl.	1,765	2	0	0	7.6%	2,295	7.8%
221-10-10160	Rude River	Head of Nelson Bay	Not surveyed						
221-10-10160-2011	Unknown	Trib to lower Rude R.	18	50	0	0	0.3%	^a	^a
Estimated total Escapement:			22,947	68	101	10	100.0%	29,472	1
Count:			12	12	12	12	12	11	11
Maximum:			15,325	50	101	10	1	19,800	1

^a Not able to calculate AUC. Only one survey occurred on stream number 221-10-10160-2011 on 6 August.

Table 3.—Daily stream counts of pink salmon from the Nelson Bay ground survey by stream number, 2004.

Date	Stream Number												Total	Cum. Percent	
	221-10										228-10				
	10100	10110	10130	10140	10155	10160-2011	10165	2004	10170	10173	18640	18650			
6/07	0	0												0	0.00
6/08			0	0	0			0	0	0	0		0	0	0.00
6/14	0	0	0	0	0									0	0.00
6/15								0	0	0	0	0	0	0	0.00
6/21	0	0	0	0	0									0	0.00
6/22								0	0	0	0		0	0	0.00
6/24												0		0	0.00
6/28	0	0	0	0	0									0	0.00
6/29								0	0	0	0		0	0	0.00
7/01												0		0	0.00
7/06	0	0	0	0	0									0	0.00
7/08								0	0	0	0	0	0	0	0.00
7/12	300	150	0	0	0									450	0.01
7/13								0	0	0	0		0	0	0.01
7/14												0		0	0.01
7/19	0	795	0	0	0									795	0.02
7/20								0	0	7	0		0	7	0.02
7/23												0		0	0.02
7/27								0	0	36	0		312	348	0.02
7/29	112	4,790	85	1	0							209		5,197	0.09
8/03	435	15,325	186	1	472									16,419	0.31
8/05								0	0	548	0	1,000	813	2,361	0.34
8/06						18								18	0.34
8/09			472	0	506									978	0.36
8/10								0	0	682	0	1,002	810	2,494	0.39
8/12	672	11,635												12,307	0.56
8/16								0	0	782	0	1,000	960	2,742	0.59
8/17			391	10	1,168									1,569	0.62
8/19	385	7,754												8,139	0.73
8/23	206							0	0	1,069	0	800	995	3,070	0.77
8/26		7,100	705	91	2,300									10,196	0.90
8/31								0	0	483	0	379	1,765	2,627	0.94

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Table 3.—Page 2 of 2.

Date	Stream Number										Total	Cum. Percent		
	221-10												228-10	
	10100	10110	10130	10140	10155	10160-2011	10165	2004	10170	10173			18640	18650
9/03	54	1,702	292	30	673								2,751	0.98
9/07							4	0	119	0			123	0.98
9/09	2	216	116	13	456								803	0.99
9/11											460	81	541	1.00
9/13	0	66											66	1.00
9/15											200	4	204	1.00
9/16							0	0	0	0			0	1.00
9/17			3	0	17								20	1.00
Total:	2,166	49,533	2,250	146	5,592	18	4	0	3,726	0	5,050	5,740	74,225	1.00
Count:	15	15	15	15	15	1	15	15	15	15	14	15		
Maximum:	672	15,325	705	91	2,300	18	4	0	1,069	0	1,002	1,765		

Table 4.—Daily stream counts of chum salmon from the Nelson Bay ground survey by stream number, 2004.

Date	Stream Number										Cum.			
	221-10										228-10		Total	Percent
10100	10110	10130	10140	10155	10160-2011	10165	2004	10170	10173	18640	18650			
6/07	0	0											0	0.00
6/08			0	0	0		0	0	0	0		0	0	0.00
6/14	0	0	0	0	0								0	0.00
6/15							0	0	0	0	0	0	0	0.00
6/21	0	0	0	0	0								0	0.00
6/22							0	0	0	0		0	0	0.00
6/24											0		0	0.00
6/28	0	0	0	0	0								0	0.00
6/29							0	0	0	0		0	0	0.00
7/01											0		0	0.00
7/06	0	0	0	0	0								0	0.00
7/08							0	0	0	0	0	0	0	0.00
7/12	0	0	0	0	0								0	0.00
7/13							0	0	0	0		0	0	0.00
7/14											0		0	0.00
7/19	0	0	0	0	0								0	0.00
7/20							0	0	0	0		0	0	0.00
7/23											0		0	0.00
7/27							0	0	2	0		0	2	0.02
7/29	0	5	0	0	0						0		5	0.07
8/03	0	7	0	0	2								7	0.15
8/05							0	0	0	0	0	0	0	0.15
8/06						50							50	0.67
8/09			0	0	5								5	0.73
8/10							0	0	2	0	0	2	4	0.77
8/12	0	9											9	0.86
8/16							0	0	2	0	0	0	2	0.88
8/17			0	0	4								4	0.93
8/19	0	4											4	0.97
8/23	0						0	0	0	0	0	0	0	0.97
8/26		0	0	0	0								0	0.97
8/31							0	0	0	0	0	0	0	0.97

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Table 4.—Page 2 of 2.

Date	Stream Number												Total	Cum. Percent
	221-10										228-10			
	10100	10110	10130	10140	10155	10160-2011	10165	2004	10170	10173	18640	18650		
9/03	0	0	0	0	0								0	0.97
9/07							0	0	0	0			0	0.97
9/09	0	0	0	0	1								1	0.98
9/11											0	0	0	0.98
9/13	0	0											0	0.98
9/15											0	0	0	0.98
9/16							0	0	0	0			0	0.98
9/17			0	0	2								2	1.00
Total:	0	25	0	0	14	50	0	0	6	0	0	2	95	1.00
Count:	15	15	15	15	15	1	15	15	15	15	14	15		
Maximum:	0	9	0	0	5	50	0	0	2	0	0	2		

Table 5.—Daily stream counts of coho salmon from the Nelson Bay ground survey by stream number, 2004.

Date	Stream Number											Total	Cum. Percent	
	221-10										228-10			
	10100	10110	10130	10140	10155	10160-2011	10165	2004	10170	10173	18640			18650
6/07	0	0											0	0.00
6/08			0	0	0		0	0	0	0		0	0	0.00
6/14	0	0	0	0	0								0	0.00
6/15							0	0	0	0	0	0	0	0.00
6/21	0	0	0	0	0								0	0.00
6/22							0	0	0	0		0	0	0.00
6/24											0		0	0.00
6/28	0	0	0	0	0								0	0.00
6/29							0	0	0	0		0	0	0.00
7/01											0		0	0.00
7/06	0	0	0	0	0								0	0.00
7/08							0	0	0	0	0	0	0	0.00
7/12	0	0	0	0	0								0	0.00
7/13							0	0	0	0		0	0	0.00
7/14											0		0	0.00
7/19	0	0	0	0	0								0	0.00
7/20							0	0	0	0		0	0	0.00
7/23											0		0	0.00
7/27							0	0	0	0		0	0	0.00
7/29	0	0	0	0	0						0		0	0.00
8/03	0	0	0	0	0								0	0.00
8/05							0	0	0	0	0	0	0	0.00
8/06						0							0	0.00
8/09			0	0	0								0	0.00
8/10							0	0	0	0	0	0	0	0.00
8/12	0	0											0	0.00
8/16							0	0	0	0	0	0	0	0.00
8/17			0	0	0								0	0.00
8/19	0	0											0	0.00
8/23	0						70	0	0	0	0	0	70	0.41
8/26		0	0	0	0								0	0.41
8/31							101	0	0	0	0	0	101	1.00

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Table 5.—Page 2 of 2.

Date	Stream Number											Total	Cum. Percent	
	221-10										228-10			
	10100	10110	10130	10140	10155	10160-2011	10165	2004	10170	10173	18640			18650
9/03	0	0	0	0	0								0	1.00
9/07							0	0	0	0			0	1.00
9/09	0	0	0	0	0								0	1.00
9/11											0	0	0	1.00
9/13	0	0											0	1.00
9/15											0	0	0	1.00
9/16							0	0	0	0			0	1.00
9/17			0	0	0								0	1.00
Total:	0	0	0	0	0	0	171	0	0	0	0	0	171	1.00
Count:	15	15	15	15	15	1	15	15	15	15	14	15		
Maximum:	0	0	0	0	0	0	101	0	0	0	0	0		

Table 6.—Daily stream counts of sockeye salmon from the Nelson Bay ground survey by stream number, 2004.

Date	Stream Number											Total	Cum. Percent	
	221-10										228-10			
	10100	10110	10130	10140	10155	10160-2011	10165	2004	10170	10173	18640			18650
6/07	0	0											0	0.00
6/08			0	0	0		0	0	0	0		0	0	0.00
6/14	0	0	0	0	0								0	0.00
6/15							0	0	0	0	0	0	0	0.00
6/21	0	0	0	0	0								0	0.00
6/22							0	0	0	0		0	0	0.00
6/24											0		0	0.00
6/28	0	0	0	0	0								0	0.00
6/29							0	0	0	0		0	0	0.00
7/01											0		0	0.00
7/06	0	0	0	0	0								0	0.00
7/08							0	0	0	0	0	0	0	0.00
7/12	0	0	0	0	0								0	0.00
7/13							0	0	0	0		0	0	0.00
7/14											0		0	0.00
7/19	0	0	0	0	0								0	0.00
7/20							0	0	0	0		0	0	0.00
7/23											0		0	0.00
7/27							0	0	0	0		0	0	0.00
7/29	0	0	0	0	0						0		0	0.00
8/03	0	0	0	0	0								0	0.00
8/05							0	0	0	0	0	0	0	0.00
8/06						0							0	0.00
8/09			0	0	0								0	0.00
8/10							0	0	0	0	0	0	0	0.00
8/12	0	0											0	0.00
8/16							0	0	0	0	0	0	0	0.00
8/17			0	0	0								0	0.00
8/19	0	0											0	0.00
8/23	0						0	0	0	0	0	0	0	0.00
8/26		0	0	0	0								0	0.00
8/31							0	0	0	0	0	0	0	0.00

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Table 6.—Page 2 of 2.

Date	Stream Number												Total	Cum. Percent	
	221-10										228-10				
	10100	10110	10130	10140	10155	10160-2011	10165	2004	10170	10173	18640	18650			
9/03	0	0	0	0	1									1	0.05
9/07							0	0	0	0				0	0.05
9/09	0	0	0	0	10									10	0.58
9/11											0	0		0	0.58
9/13	0	0												0	0.58
9/15											0	0		0	0.58
9/16							0	0	0	0				0	0.58
9/17			0	0	8									8	1.00
Total:	0	0	0	0	19	0	0	0	0	0	0	0	0	19	1.00
Count:	15	15	15	15	15	1	15	15	15	15	14	15			
Maximum:	0	0	0	0	10	0	0	0	0	0	0	0			

Table 7.—Current and newly documented anadromous fish use for streams within the Nelson Bay study area, 2004.

Anadromous Stream Catalog		In Current Anadromous Stream Catalog ^a						Documented in 2004 ^a								
		Pink		Chum		Coho		Pink		Chum		Coho		Sockeye		
		S	R	S	R	S	R	S	R	S	R	S	R	S	R	
221-10-10100	Little Humpback	X														
221-10-10110	Humpback Cr.	X								X						
221-10-10130	Unknown	X														
221-10-10140	Unknown	X														
221-10-10155	Unknown	X								X					X	
221-10-10165	Unknown	X												X		
221-10-10170	Robinson Falls Cr.	X								X						
221-10-10170-2004	Unknown	X												X		
221-10-10173	Unknown	X												X		
228-10-18640	Unknown	X														
228-10-18650	Deep Creek	X								X				X		
221-10-10160	Rude River	X				X										
221-10-10160-2011	Unknown	X								X						
Total:		13	0	0	0	1	0	0	0	5	0	0	0	4	1	0

^a S = spawning and R = rearing.

Table 8.—Estimated total available spawning area (ASA) for streams within the Nelson Bay study area, 2004.

Stream			Available Spawning Area (m ²) ^a			Percent of
Number	Name	Region	Tidal	Upstream	Total	Total
221-10-10100	Little Humpback	N. Orca Inlet	220	501	721	4.5%
221-10-10110	Humpback Cr.	N. Orca Inlet	3,527	2,750	6,277	39.0%
221-10-10130	Unknown	N. of Shepherd Pt.	998	199	1,197	7.4%
221-10-10140	Unknown	NE Nelson Bay	242	686	928	5.8%
221-10-10155	Unknown	E. Rude River delta	746	2,756	3,502	21.7%
221-10-10165	Unknown	W. Rude River delta	Not surveyed			
221-10-10170	Robinson Falls Cr.	NW Nelson Bay	1,042	713	1,756	10.9%
221-10-10170-2004	Unknown	NW Nelson Bay	Not surveyed			
221-10-10173	Unknown	NW Nelson Bay	272	0	272	1.7%
228-10-18640	Unknown	N. Hawkins Isl.	356	37	393	2.4%
228-10-18650	Deep Cr.	N. Hawkins Isl.	460	598	1,058	6.6%
221-10-10160	Rude River	Head of Nelson Bay	Not surveyed			
221-10-10160-2011	Unknown	Trib to lower Rude R.	Not surveyed			
Total:			7,862	8,241	16,103	100.0%
Count:			9	9	9	
Maximum:			3,527	2,756	6,277	

^a Available Spawning Area (ASA) was calculated as Length (of survey section) * Width (of survey section) * Percent of gravel (within each survey section) = Total estimated ASA by stream.

Table 9.—Estimated number of pink salmon spawners, egg deposition, and fry production from estimated available spawning area (ASA) for nine of the inventoried streams within the Nelson Bay study area, 2004.

Stream Number	ASA (m ²)		Estimated Number of Spawners ^a			Estimated Egg Deposition ^b			Estimated Fry Production ^c		
			LOWER	MEAN	UPPER	LOWER	MEAN	UPPER	LOWER	MEAN	UPPER
221-10-10100	721	4.5%	72	656	721	131,384	1,194,404	1,313,844	5,650	51,359	56,495
221-10-10110	6,277	39.0%	628	5,706	6,277	1,143,578	10,396,166	11,435,783	49,174	447,035	491,739
221-10-10130	1,197	7.4%	120	1,088	1,197	218,002	1,981,839	2,180,023	9,374	85,219	93,741
221-10-10140	928	5.8%	93	844	928	169,118	1,537,437	1,691,180	7,272	66,110	72,721
221-10-10155	3,502	21.7%	350	3,184	3,502	638,046	5,800,420	6,380,462	27,436	249,418	274,360
221-10-10165											
221-10-10170	1,756	10.9%	176	1,596	1,756	319,907	2,908,243	3,199,068	13,756	125,054	137,560
221-10-10170-2004											
221-10-10173	272	1.7%	27	247	272	49,467	449,703	494,673	2,127	19,337	21,271
228-10-18640	393	2.4%	39	357	393	71,586	650,785	715,864	3,078	27,984	30,782
228-10-18650	1,058	6.6%	106	962	1,058	192,840	1,753,095	1,928,405	8,292	75,383	82,921
221-10-10160											
221-10-10160-2011											
Total:	16,103	100.0%	1,610	14,639	16,103	2,933,930	26,672,092	29,339,302	126,159	1,146,900	1,261,590
Maximum:	6,277	39.0%	628	5,706	6,277	1,143,578	10,396,166	11,435,783	49,174	447,035	491,739

^a Estimated number of spawners was calculated using pink salmon spawning density estimates from McNeil (1967) and Eniutina (1972). Mean of 1.1 spawners / m².

^b Estimated egg deposition was calculated using the estimated average pink salmon fecundity (eggs/female) of 1,822 in Olsen Creek, PWS; Helle (1970), Helle et al. (1964).

^c Estimated fry production was calculated using the mean freshwater survival (4.3%) from Auke Creek in southeast Alaska (1971–1981); Taylor (1983).

Table 10.—Escapement estimation using peak counts and area under the curve (AUC) for pink, chum, coho and sockeye from aerial surveys within the Nelson Bay study area, 2004.

Stream			Peak Counts					AUC ^a	
			Pink	Chum	Coho	Sockeye	Percent of	Percent of	
Number	Name	Region					Total	Pink	Total
221-10-10100	Little Humpback	N. Orca Inlet	40	0	0	0	0.3%	20	0.1%
221-10-10110	Humpback Cr.	N. Orca Inlet	9,000	250	0	0	70.9%	14,000	79.3%
221-10-10130	Unknown	N. of Shepherd Pt.	300	20	0	0	2.5%	264	1.5%
221-10-10140	Unknown	NE Nelson Bay	100	2	0	0	0.8%	56	0.3%
221-10-10155	Snyder Falls Cr.	E. Rude River delta	2,000	50	0	0	15.7%	1,820	10.3%
221-10-10160	Rude River	Head of Nelson Bay	0	0	0	0	0.0%	0	0.0%
221-10-10160-2011	Unknown	Trib to lower Rude R.	0	0	0	0	0.0%	0	0.0%
221-10-10165	Unknown	W. Rude River delta	20	0	0	0	0.2%	8	0.0%
221-10-10170	Robinson Falls Cr.	NW Nelson Bay	1,000	4	0	0	7.7%	1,132	6.4%
221-10-10170-2004	Unknown	NW Nelson Bay	0	0	0	0	0.0%	0	0.0%
221-10-10173	Unknown	NW Nelson Bay	0	0	0	0	0.0%	0	0.0%
228-10-18640	Unknown	N. Hawkins Isl.	150	0	0	0	1.2%	220	1.2%
228-10-18650	Deep Cr.	N. Hawkins Isl.	100	0	0	0	0.8%	130	0.7%
221-10-10160-2165	Unknown	N. Fork Rude River	0	0	0	0	0.0%	0	0.0%
221-10-10160-2175	Unknown	N. Fork Rude River	0	0	5	0	0.0%	0	0.0%
221-10-10160-2185	Unknown	N. Fork Rude River	0	0	0	0	0.0%	0	0.0%
221-10-10160-2190	Unknown	N. Fork Rude River	0	0	0	0	0.0%	0	0.0%
221-10-10160-2100	Unknown	N. Fork Rude River	0	0	0	0	0.0%	0	0.0%
221-10-10160-2200	Unknown	N. Fork Rude River	0	0	0	0	0.0%	0	0.0%
Estimated total Escapement:			12,710	326	5	0	100.0%	17,650	
Count:			19	19	19	19		19	
Maximum:			9,000	250	5	0		14,000	

^a Escapement estimate calculated using area under the curve. Corrected for 17.5 days stream life and assumed no observer bias.

Table 11.—Total pink, chum, coho, sockeye, and Chinook salmon catch by sample location from the Nelson Bay test fishery, 2004.

Species	Sample Site								Total
	Bomb Point (Site 1)	N. Hawkins Island (Site 2)	Channel Islands (Site 3)	Salmo Point (Site 4)	W. Nelson Bay (Site 5)	Shepherd Point (Site 6)	NW Nelson Bay (Site 7)	NE Nelson Bay (Site 8)	
pink salmon	465	2,284	408	562	94	42	16	15	3,886
chum salmon	47	135	63	72	18	2	6	53	396
coho salmon	58	64	169	15	63	15	34	30	448
sockeye salmon	7	6	6	2	3	0	2	3	29
Chinook salmon	1	0	1	0	0	2	0	1	5
Total:	578	2,489	647	651	178	61	58	102	4,759
Percent:	12.1%	52.3%	13.6%	13.7%	3.7%	1.3%	1.2%	2.1%	

Table 12.–Pink salmon catches from the Nelson Bay test fishery by sample location, 2004.

Date	Sample Site								Total	Average	Cum. Percent Complete
	Bomb Point (Site 1)	N. Hawkins Island (Site 2)	Channel Islands (Site 3)	Salmo Point (Site 4)	W. Nelson Bay (Site 5)	Shepherd Point (Site 6)	NW Nelson Bay (Site 7)	NE Nelson Bay (Site 8)			
6/06	0	0	0						0	0	0.00
6/11				0	0	0	0	0	0	0	0.00
6/13	0	0	0	0					0	0	0.00
6/16			0	0	0	0	0		0	0	0.00
6/20	0	0	0	0					0	0	0.00
6/23			0	0	0	0	0	0	0	0	0.00
6/27			6	0	1		0	0	7	1	0.00
6/30	18	0	1	0	0	1			20	3	0.01
7/04			11	23	0			0	34	9	0.02
7/07	20	20	20	18	1	0			79	13	0.04
7/11			18		12		0	1	31	8	0.04
7/15	40	30	80	12	30	1	0	2	195	24	0.09
7/18			5	10	4	2	1	0	22	4	0.10
7/21	50	15	15	30	5	9			124	21	0.13
7/25	35	450	50	10	19	1	3	2	570	71	0.28
7/28	40	135	8	8		0	1		192	32	0.33
8/01	200	500	50	200		0		0	950	158	0.57
8/04	19	400	36	200	11	18	2	9	695	87	0.75
8/08	18	300	35	4	10		4		371	62	0.85
8/11	6	300	15	0		8		0	329	55	0.93
8/15	10	100	10	15					135	34	0.97
8/18	2	10	30	18		0	5		65	11	0.98
8/22	5	15	3	12	0			1	36	6	0.99
8/25	2	4	9	2	1	2	0	0	20	3	1.00
9/01	0	5	5	0	0				10	2	1.00
9/05	0	0	0		0		0	0	0	0	1.00
9/08			1	0	0	0	0	0	1	0	1.00
9/12	0	0	0		0		0	0	0	0	1.00
9/15			0	0	0	0			0	0	1.00
Total:	465	2,284	408	562	94	42	16	15	3,886		
Count:	20	20	28	25	21	17	16	16			

Table 13.—Chum salmon catches from the Nelson Bay test fishery by sample location, 2004.

Date	Sample Site								Total	Average	Cum. Percent Complete
	Bomb Point (Site 1)	N. Hawkins Island (Site 2)	Channel Islands (Site 3)	Salmo Point (Site 4)	W. Nelson Bay (Site 5)	Shepherd Point (Site 6)	NW Nelson Bay (Site 7)	NE Nelson Bay (Site 8)			
6/06	0	3	0	0					3	1	0.01
6/11					0	0	0	0	0	0	0.01
6/13	0	2	2	0					4	1	0.02
6/16			0	0	0	0	0		0	0	0.02
6/20	4	2	8	3					17	4	0.06
6/23			3	0	5	1	3	50	62	10	0.22
6/27			1	2	0		0	0	3	1	0.22
6/30	11	10	0	1	0	0			22	4	0.28
7/04			0	12	1			1	14	4	0.32
7/07	3	4	10	20	4	0			41	7	0.42
7/11			2		0		0	0	2	1	0.42
7/15	5	6	10	5	4	0	0	0	30	4	0.50
7/18			2	5	0	0	0	0	7	1	0.52
7/21	4	1	2	0	2	0			9	2	0.54
7/25	5	50	10	2	1	0	0	2	70	9	0.72
7/28	7	15	4	0		0	2		28	5	0.79
8/01	0	15	5	10		0		0	30	5	0.86
8/04	4	15	1	10	0	0	1	0	31	4	0.94
8/08	3	0	0	0	1		0		4	1	0.95
8/11	0	0	0	0		0		0	0	0	0.95
8/15	0	10	0	0					10	3	0.98
8/18	1	0	2	2		1	0		6	1	0.99
8/22	0	2	0	0	0			0	2	0	1.00
8/25	0	0	1	0	0	0	0	0	1	0	1.00
9/01	0	0	0	0	0				0	0	1.00
9/05	0	0	0		0		0	0	0	0	1.00
9/08			0	0	0	0	0	0	0	0	1.00
9/12	0	0	0		0		0	0	0	0	1.00
9/15			0	0	0	0			0	0	1.00
Total:	47	135	63	72	18	2	6	53	396		
Count:	20	20	28	25	21	17	16	16			

Table 14.—Coho salmon catches from the Nelson Bay test fishery by sample location, 2004.

Date	Sample Site								Total	Average	Cum. Percent Complete
	Bomb Point (Site 1)	N. Hawkins Island (Site 2)	Channel Islands (Site 3)	Salmo Point (Site 4)	W. Nelson Bay (Site 5)	Shepherd Point (Site 6)	NW Nelson Bay (Site 7)	NE Nelson Bay (Site 8)			
6/06	0	0	0						0	0	0.00
6/11				0	0	0	0	0	0	0	0.00
6/13	0	0	0	0					0	0	0.00
6/16			0	0	0	0	0		0	0	0.00
6/20	0	0	0	0					0	0	0.00
6/23			0	0	0	0	0	0	0	0	0.00
6/27			0	0	0		0	0	0	0	0.00
6/30	0	0	1	0	0	0			1	0	0.00
7/04			0	1	0			0	0	0	0.00
7/07	0	0	1	0	0	0			1	0	0.00
7/11			1		0		0	0	1	0	0.01
7/15	3	0	1	0	1	0	0	0	5	1	0.02
7/18			0	0	0	0	0	0	0	0	0.02
7/21	1	0	0	0	0	0			1	0	0.02
7/25	0	0	0	0	0	0	0	0	0	0	0.02
7/28	0	0	0	0		0	1		1	0	0.02
8/01	0	0	0	5		0		0	5	1	0.03
8/04	2	10	0	0	0	0	0	0	12	2	0.06
8/08	0	0	0	0	0		0		0	0	0.06
8/11	0	15	0	0		0		0	15	3	0.09
8/15	1	5	3	0					9	2	0.11
8/18	11	5	18	4		1	9		48	8	0.22
8/22	37	12	50	2	2			11	114	19	0.48
8/25	0	9	62	0	10	2	1	0	84	11	0.66
9/01	0	1	2	0	3				6	1	0.68
9/05	2	1	21		7		6	0	37	6	0.76
9/08			2	4	36	5	16	7	70	12	0.92
9/12	1	6	2		1		1	12	23	4	0.97
9/15			5	0	3	7			15	4	1.00
Total:	58	64	169	16	63	15	34	30	448		
Count:	20	20	28	25	21	17	16	16			

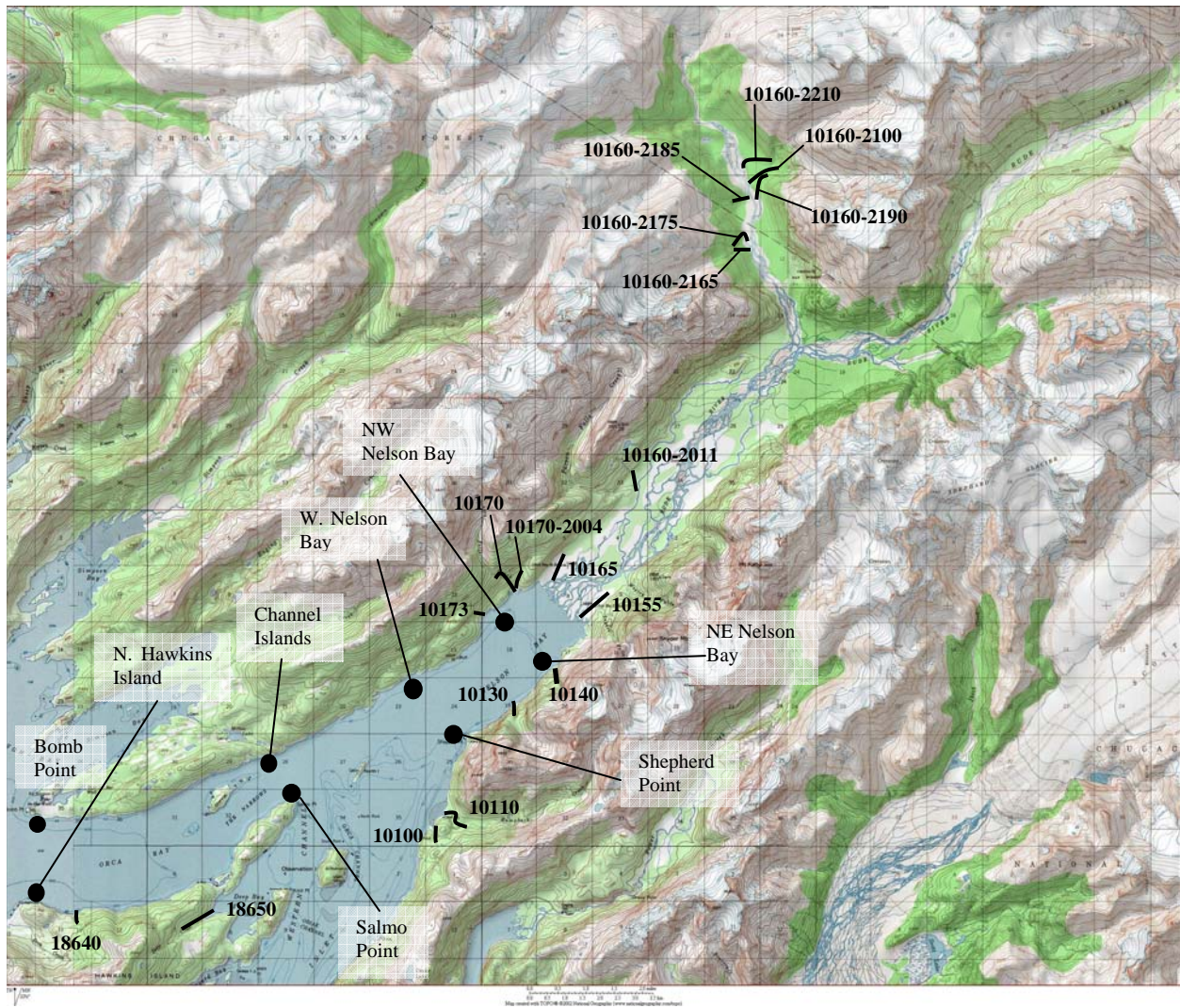
Table 15.–Sockeye salmon catches from the Nelson Bay test fishery by sample location, 2004.

Date	Sample Site								Total	Average	Cum. Percent Complete
	Bomb Point (Site 1)	N. Hawkins Island (Site 2)	Channel Islands (Site 3)	Salmo Point (Site 4)	W. Nelson Bay (Site 5)	Shepherd Point (Site 6)	NW Nelson Bay (Site 7)	NE Nelson Bay (Site 8)			
6/06	0	0	0						0	0	0.00
6/11				0	0	0	0	0	0	0	0.00
6/13	1	1	0	0					2	1	0.07
6/16			1	0	0	0	1		2	0	0.14
6/20	0	1	0	0					1	0	0.17
6/23			0	0	0	0	0	0	0	0	0.17
6/27			1	0	0		0	0	1	0	0.21
6/30	1	0	0	0	0	0			1	0	0.24
7/04			2	0	0			1	3	1	0.34
7/07	0	0	0	0	0	0			0	0	0.34
7/11			0		0		0	0	0	0	0.34
7/15	1	4	0	0	3	0	0	1	9	1	0.66
7/18			0	0	0	0	0	0	0	0	0.66
7/21	0	0	0	0	0	0			0	0	0.66
7/25	0	0	0	0	0	0	0	1	1	0	0.69
7/28	0	0	1	0		0	0		1	0	0.72
8/01	3	0	1	0		0		0	4	1	0.86
8/04	0	0	0	0	0	0	0	0	0	0	0.86
8/08	1	0	0	0	0		1		2	0	0.93
8/11	0	0	0	0		0		0	0	0	0.93
8/15	0	0	0	0					0	0	0.93
8/18	0	0	0	1		0	0		1	0	0.97
8/22	0	0	0	0	0			0	0	0	0.97
8/25	0	0	0	0	0	0	0	0	0	0	0.97
9/01	0	0	0	0	0				0	0	0.97
9/05	0	0	0		0		0	0	0	0	0.97
9/08			0	1	0	0	0	0	1	0	1.00
9/12	0	0	0		0		0	0	0	0	1.00
9/15			0	0	0	0			0	0	1.00
Total:	7	6	6	2	3	0	2	3	29		
Count:	20	20	28	25	21	17	16	16			

Table 16.—Estimated hatchery and wild stock contributions to the Nelson Bay test fishery by species and sample location, 2004.

Date	Stat Week	Species	Site No.	No. Otoliths	No. Fish Caught	Percent		Total		No. Hatchery ^a				
						Wild	Hatchery	Wild	Hatchery	WNH	AFK	CCH	MBH	SG
7/15	29	pink	1, 2, 3, 5	30	195	0.93	0.07	182	13	0	0	0	0	13
7/21	30	chum	1	3	3	0.67	0.33	2	1	1	0	0	0	0
7/21	30	pink	1, 4	12	124	1.00	0.00	124	0	0	0	0	0	0
7/25	31	chum	2	5	5	1.00	0.00	5	0	0	0	0	0	0
7/25	31	pink	1, 2, 3	33	570	1.00	0.00	570	0	0	0	0	0	0
7/28	31	pink	1, 2	34	192	1.00	0.00	192	0	0	0	0	0	0
8/1	32	pink	1, 2, 3, 4	180	950	0.99	0.01	945	5	0	0	0	0	5
8/4	32	pink	2, 4	75	600	1.00	0.00	600	0	0	0	0	0	0
8/8	33	pink	2, 3	67	371	1.00	0.00	371	0	0	0	0	0	0
8/11	33	pink	2	60	63	1.00	0.00	63	0	0	0	0	0	0
Total:				499	3,073			3,054	19	1	0	0	0	18
Maximum:				180	950	1.00	0.33	945	13	1	0	0	0	13

^a WNH - Wally Noerenberg Hatchery, AFK - Armin F. Koernig Hatchery, CCH - Cannery Creek Hatchery, SG - Solomon Gulch Hatchery. All hatcheries except SG (run by Valdez Fisheries Development Association) are run by the Prince William Sound Aquaculture Corporation Inc (PWSAC).



Note: A bold black line indicates streams inventoried by both aerial and ground survey methods along with stream number. Test fishery sample locations are indicated by a solid dot.

Figure 1.–Nelson Bay study area, 2004.

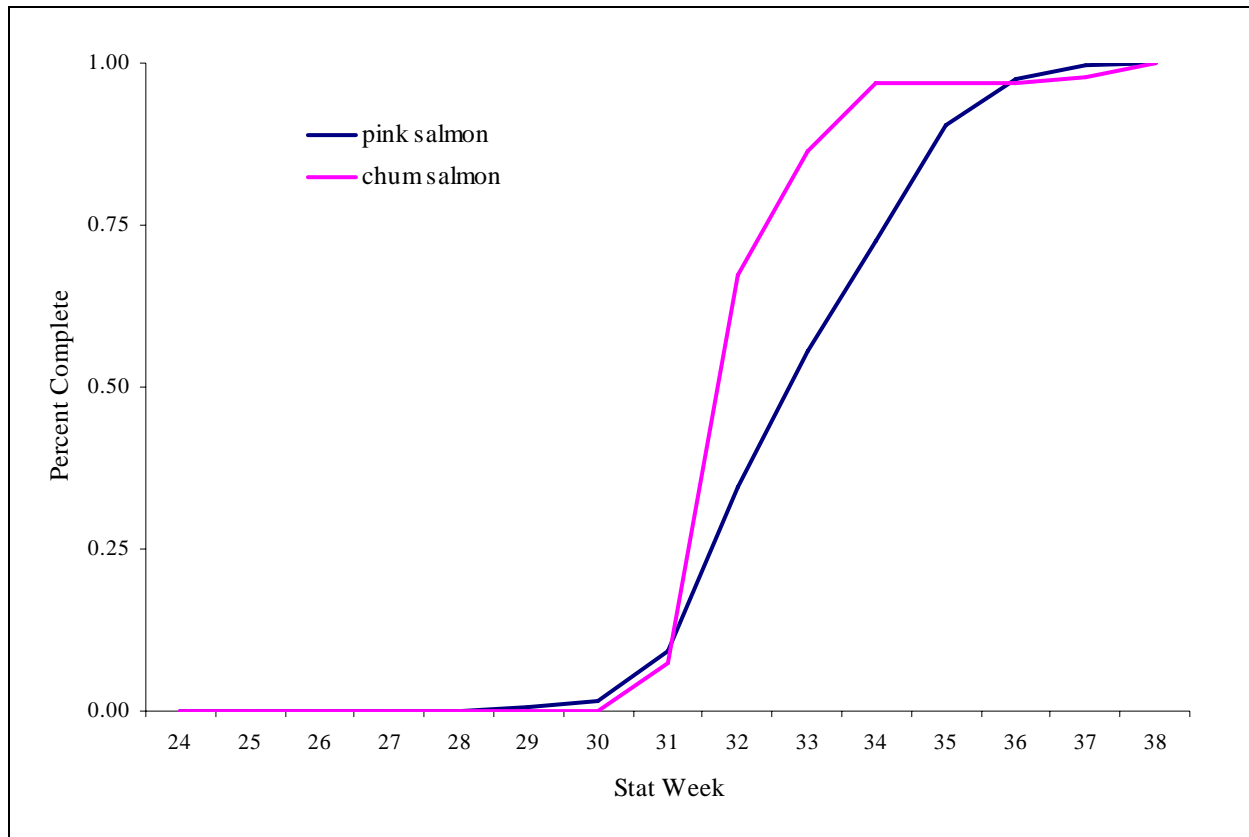
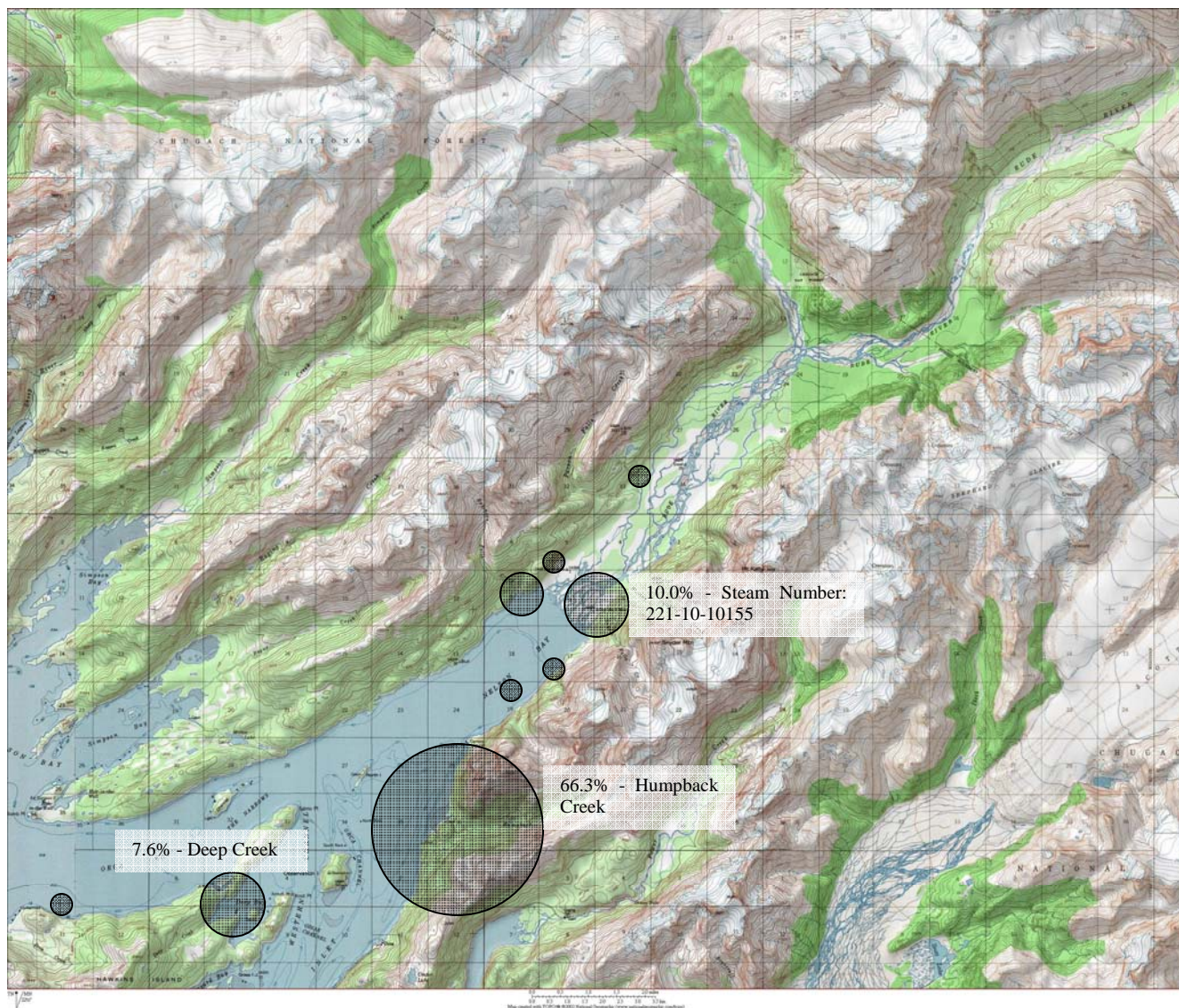
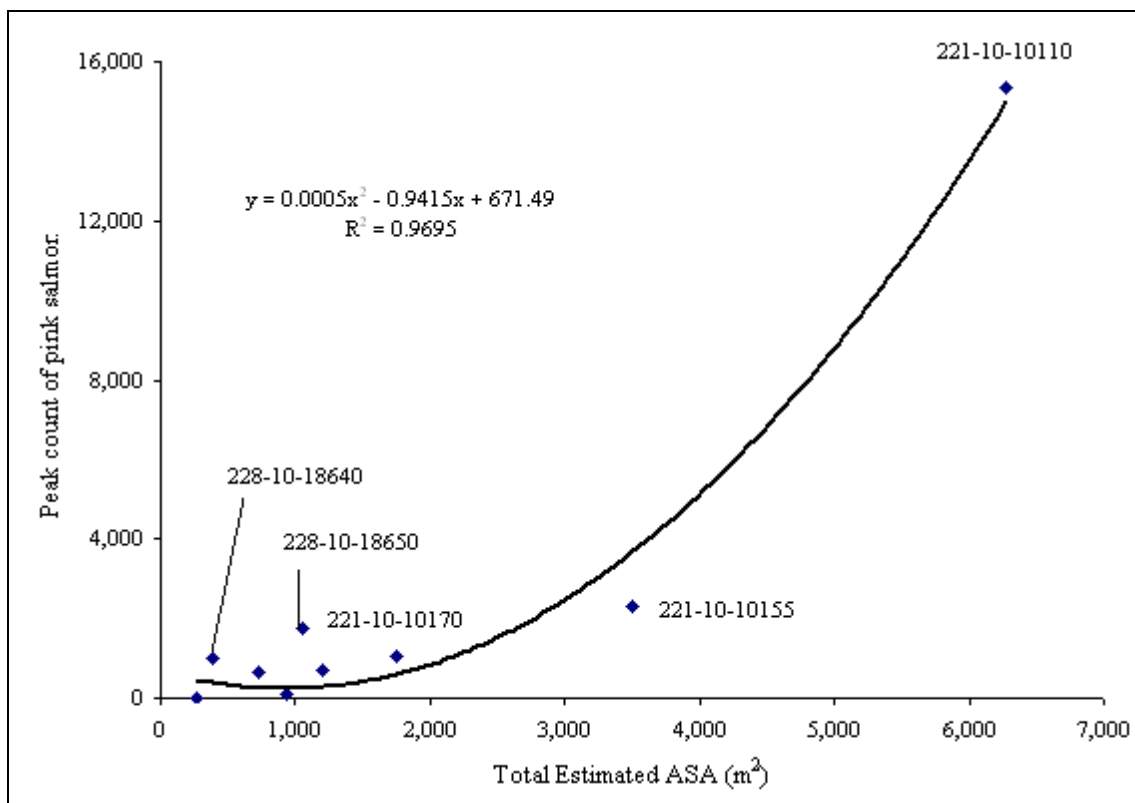


Figure 2.—Pink and chum salmon escapement timing by statistical week based on ground survey data for all streams in the Nelson Bay study area, 2004.



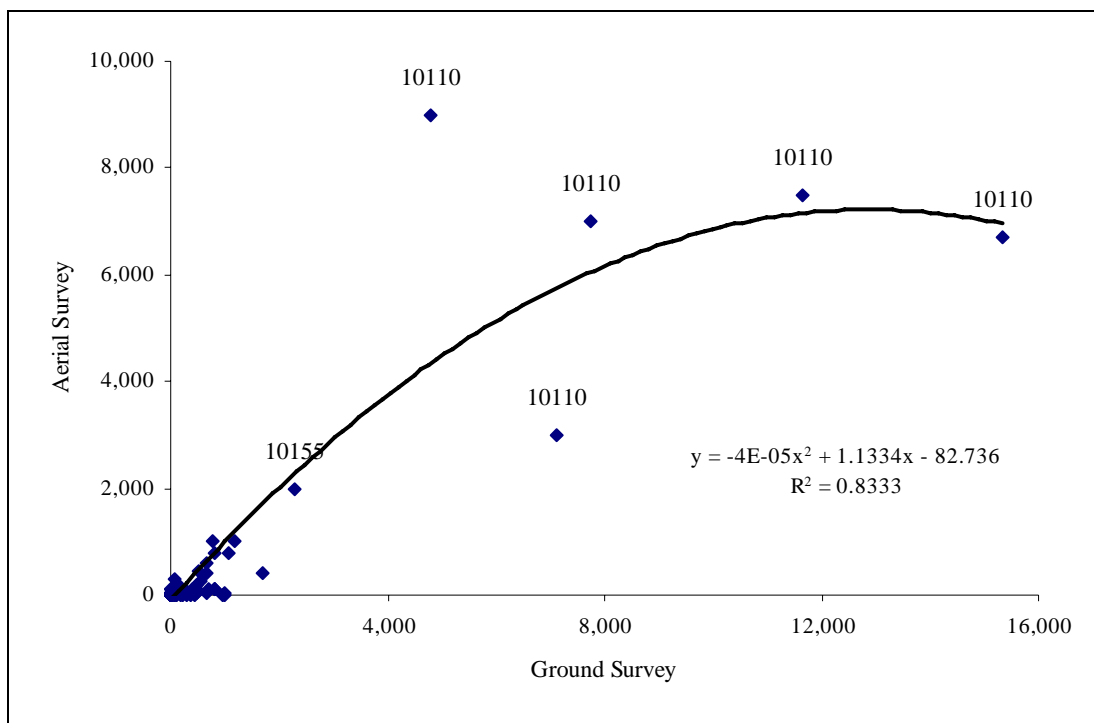
Note: The data are peak counts of pink, chum, coho, and sockeye salmon generated from weekly ground surveys.

Figure 3.—Percent of total salmon escapement by stream, 2004.



Note: Streams highlighted are Humpback Creek (10110), Deep Creek (18650), and unnamed streams (10155, 10170, and 18640).

Figure 4.—Correlation between escapement peak counts for pink salmon and estimated available spawning area (ASA) for 9 streams from which ground surveys were completed.



Note: Data points represent one observation per statistical week for both aerial and ground surveys. Stream number 10110 is Humpback Creek, 10155 is the unnamed stream on the east side of the Rude River delta.

Figure 5.—Correlation between aerial and ground survey observations of pink salmon escapement in the Nelson Bay study area streams, 2004.

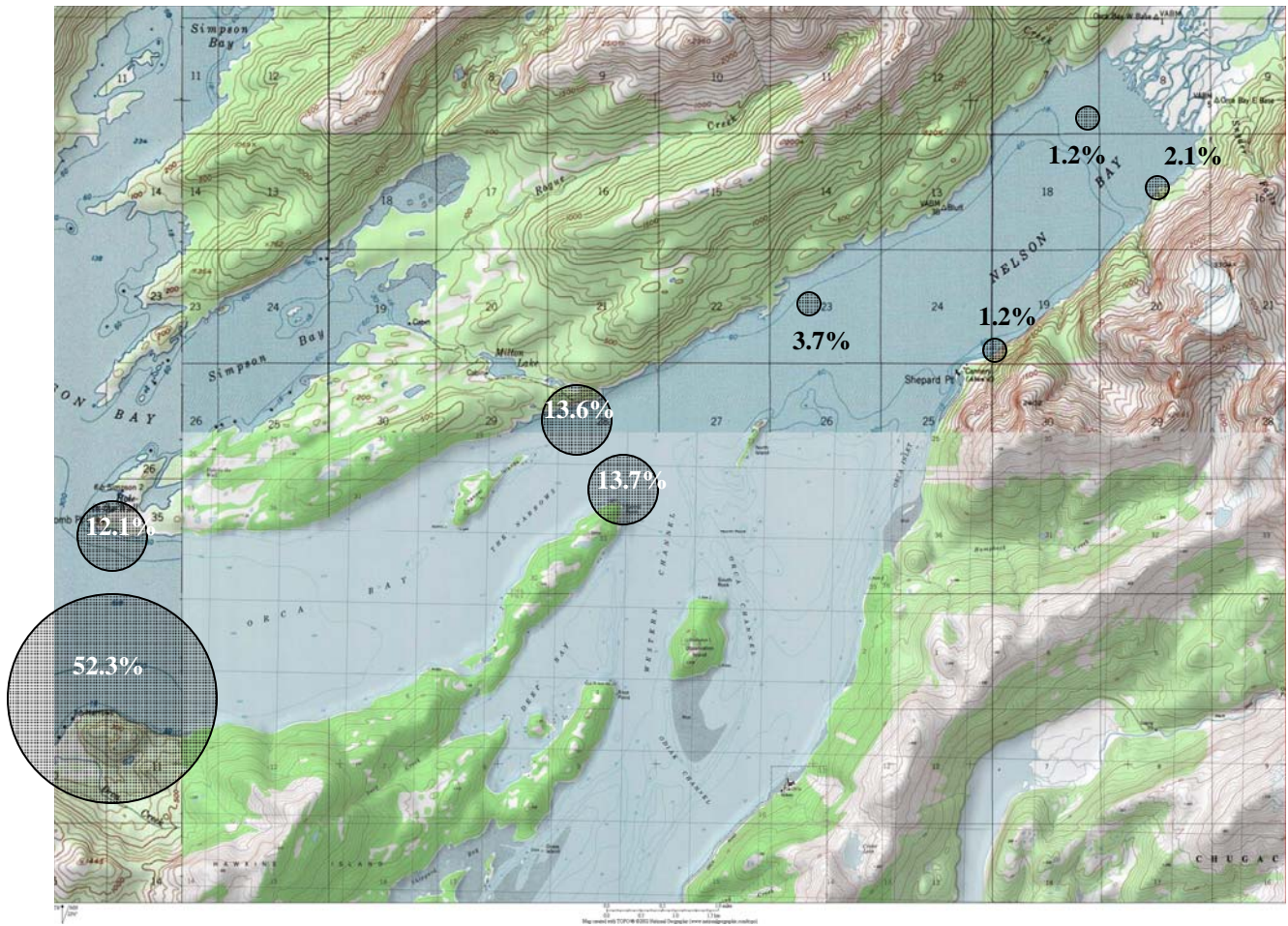


Figure 6.—Percentage of total catch (all salmon species) by sample location from the Nelson Bay test fishery, 2004.

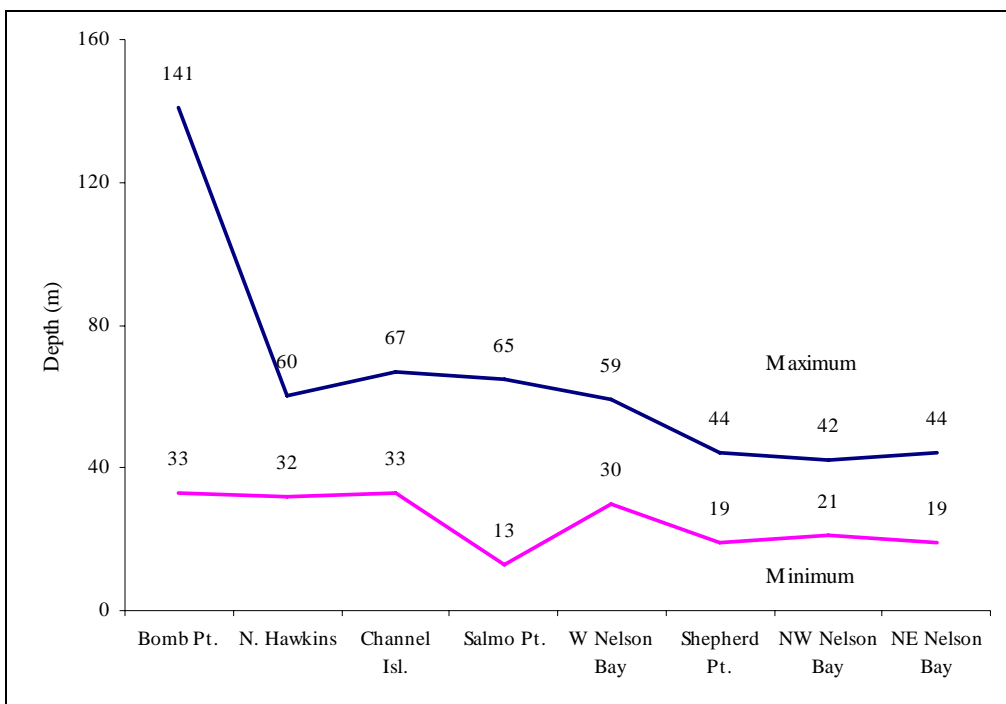


Figure 7.—Minimum and maximum depth (m) by sample location for the Nelson Bay test fishery, 2004.

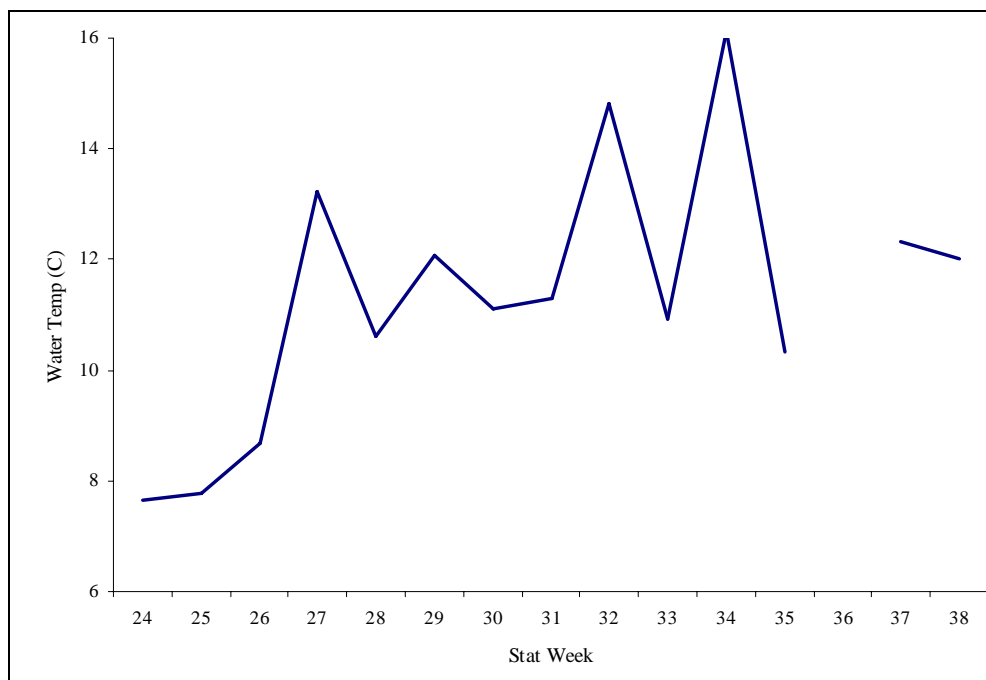


Figure 8.—Average weekly water temperatures (C) among all sample locations of the Nelson Bay test fishery, 2004.

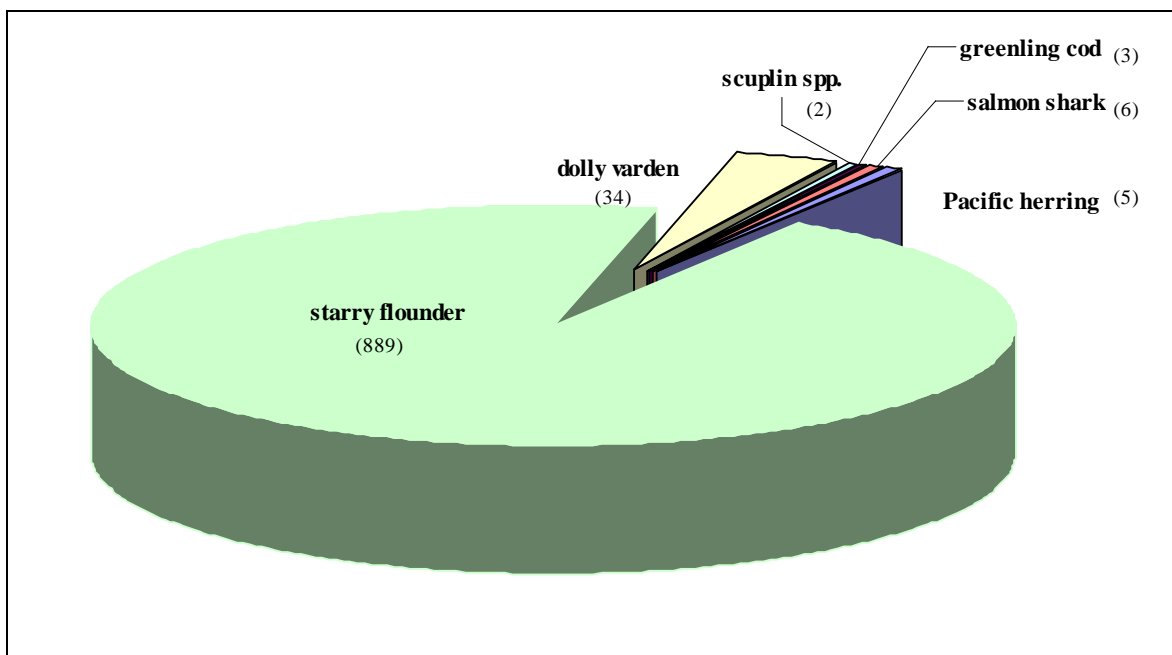
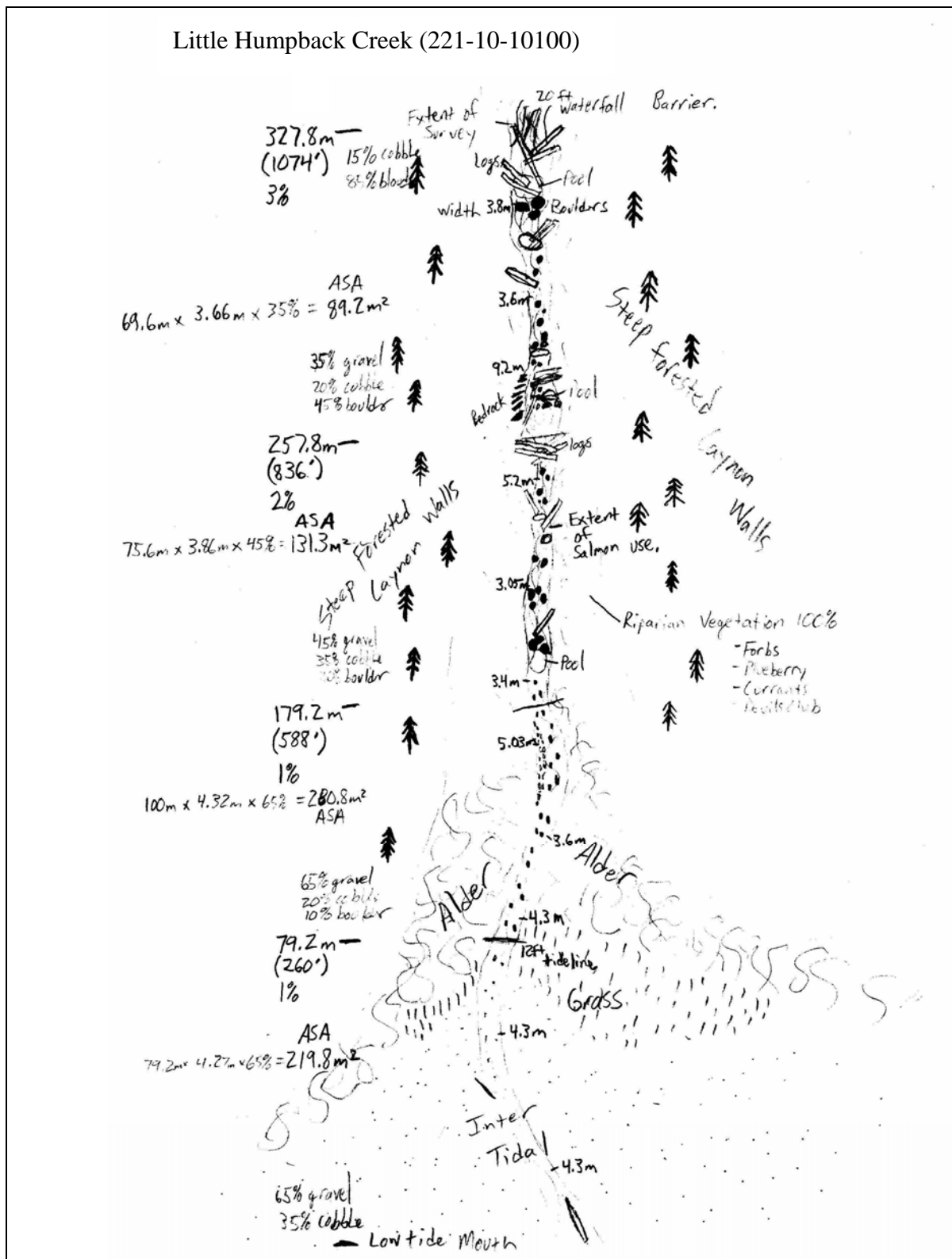


Figure 9.—By-catch from the Nelson Bay test fishery, 2004.

APPENDIX A. GROUND SURVEYS

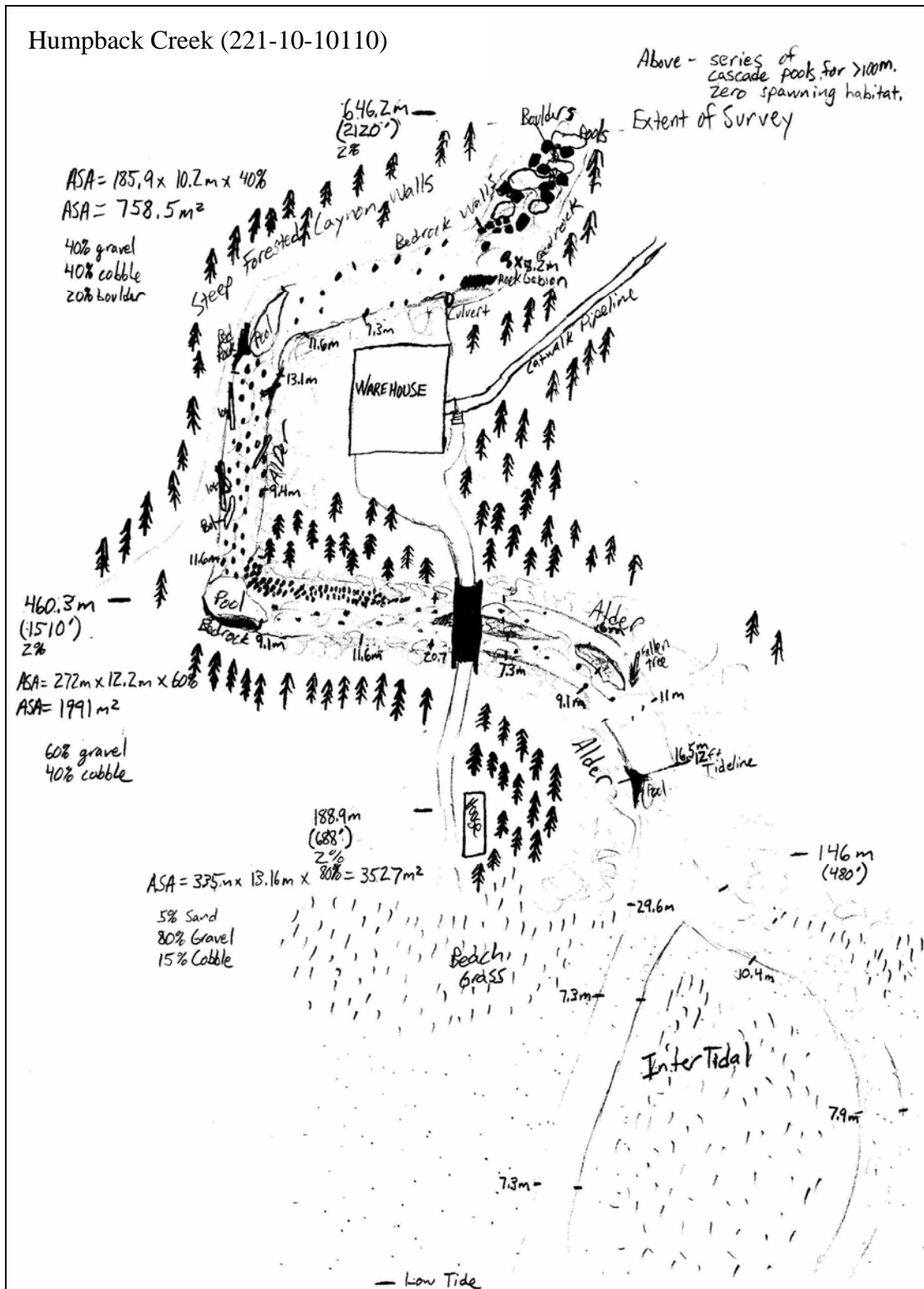
Appendix A1.—Map of Little Humpback Creek (221-10-10100) with assorted woody debris, passage barriers, or other habitat related formations.



Appendix A2.—Photograph of Humpback Creek (221-10-10100) and Little Humpback Creek (221-10-10110; on the right) on the eastern shore of Orca Inlet.



Appendix A3.—Map of Humpback Creek (221-10-10110) with assorted woody debris, passage barriers, or other habitat related formations.



Hand-drawn map of a coastal area, likely a beach or tidal flat, showing various zones and measurements. The map includes a "Barrier - 30ft water fall" at the top, a "Beach" area, and an "Inter Tidal" zone. The map is divided into several sections, each with specific measurements and percentages of gravel, cobble, and boulder content.

Top Section (Barrier - 30ft water fall):

- 299m (988')
- 1%
- 40% gravel
- 40% cobble
- 20% Boulder

Left Section (Beach):

- 238m (781')
- 3%
- 50% gravel / 30% cobble / 20% Boulder

Bottom Left Section (Inter Tidal):

- 226.5m (743')
- 1.5%
- 85% gravel
- 15% cobble

Bottom Section (Inter Tidal):

- 132.6m (435')
- 2%
- 80% gravel
- 20% cobble

Right Section (Alder):

- 5.02m
- 5.5m
- 5.02m
- 5.3m
- 12 ft Tide line
- 4m
- 5.8m
- 2.6m
- 4.1m
- 5.2m
- 6.4m
- 5.2m

Other Labels:

- Bedrock
- Logs
- Barrier - 30ft water fall
- Beach
- Inter Tidal
- Alder
- Low Tide

Appendix A5.—Photographs of the unnamed stream number 221-10-10130 located north of Shepherd Point.



Photo A: Mouth of stream.

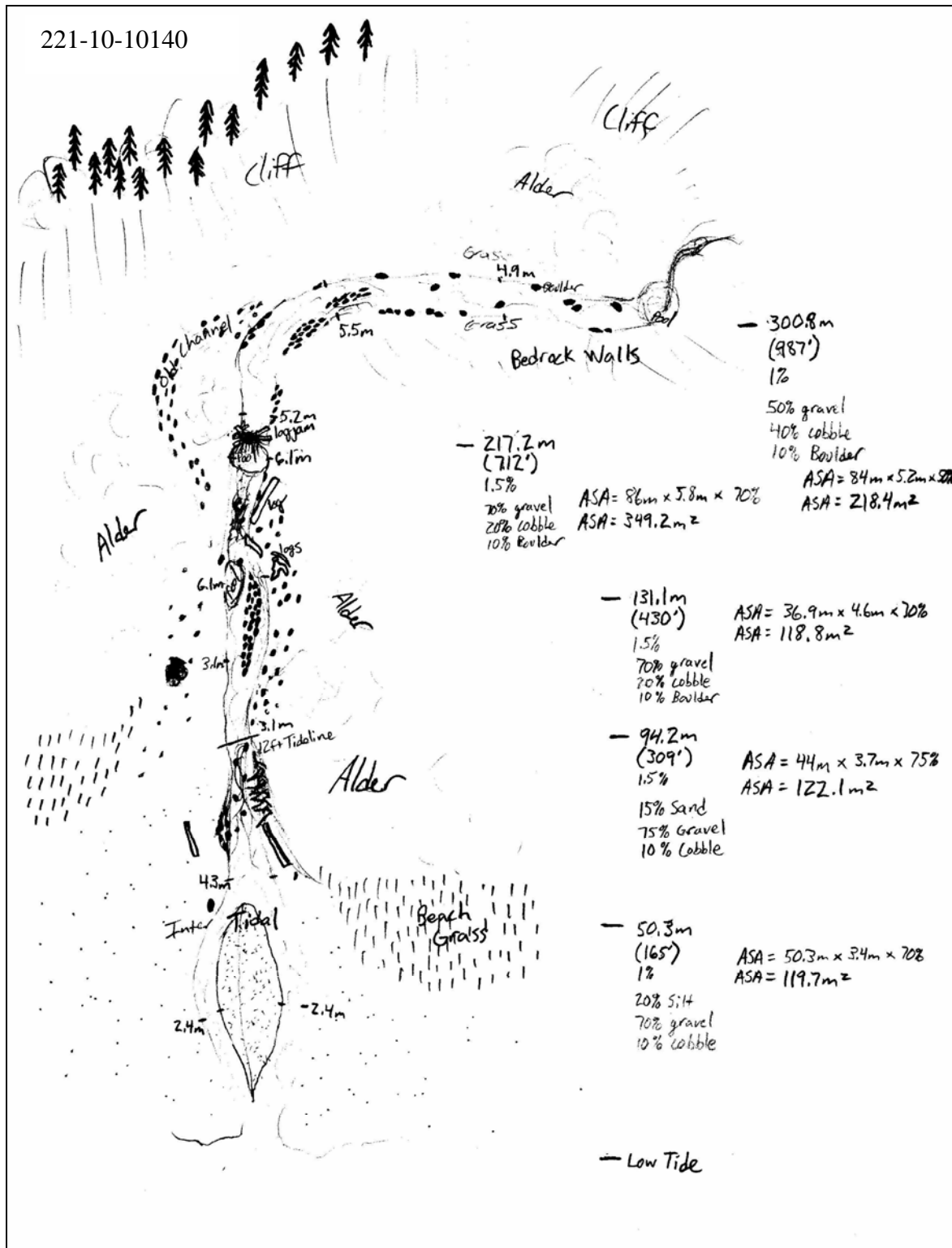


Photo B: Looking upstream 132m from mouth.



Photo C: Section A. Looking upstream 226m from mouth.

Appendix A6.—Map of the unnamed stream 221-10-10140 with assorted woody debris, passage barriers, or other habitat related formations.



Appendix A7.—Photographs of the unnamed stream number 221-10-10140 located in the northeastern corner of Nelson Bay.



Photo A: 12 ft High Tide line looking downstream towards mouth.

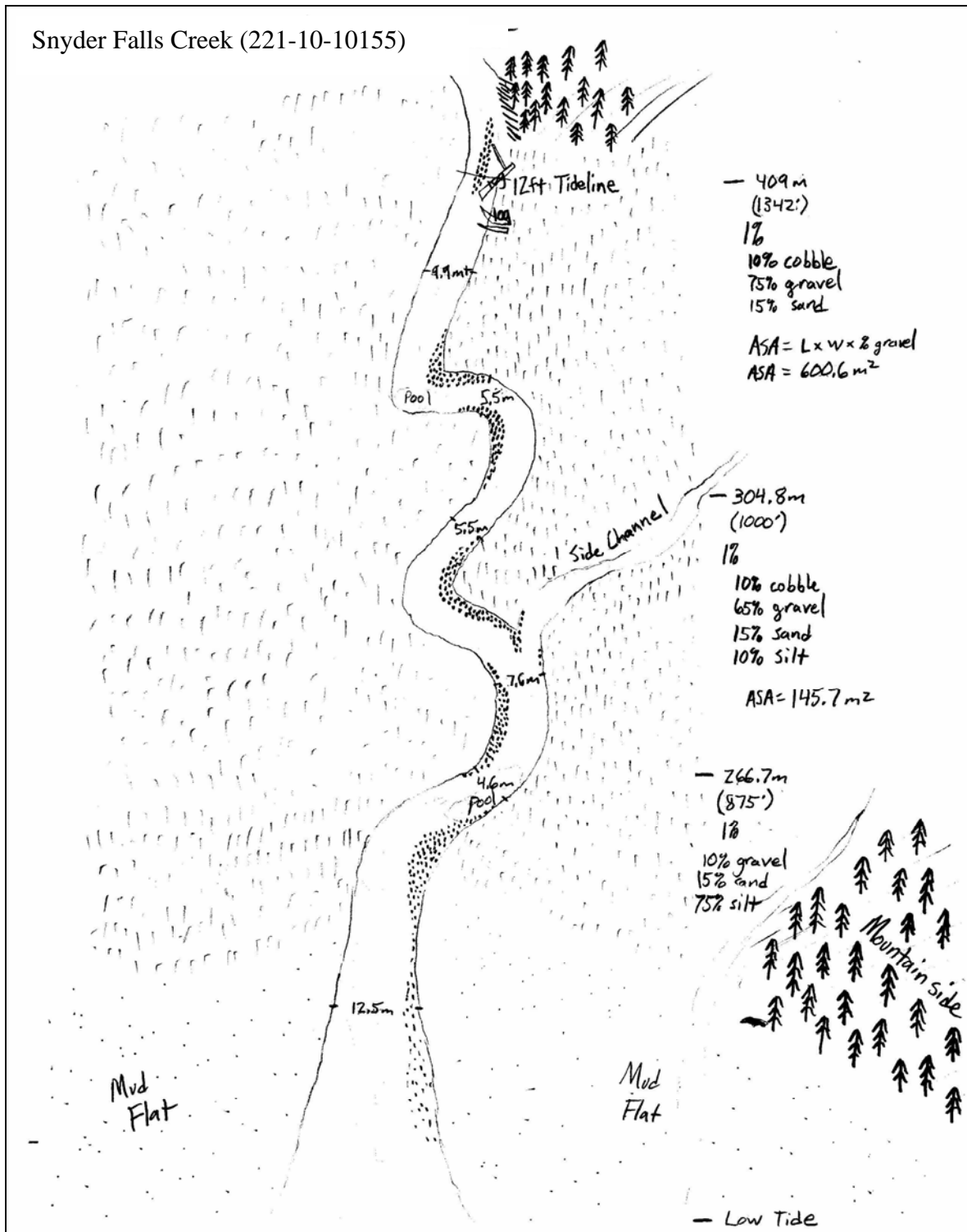


Photo B: Looking upstream 218m from mouth.



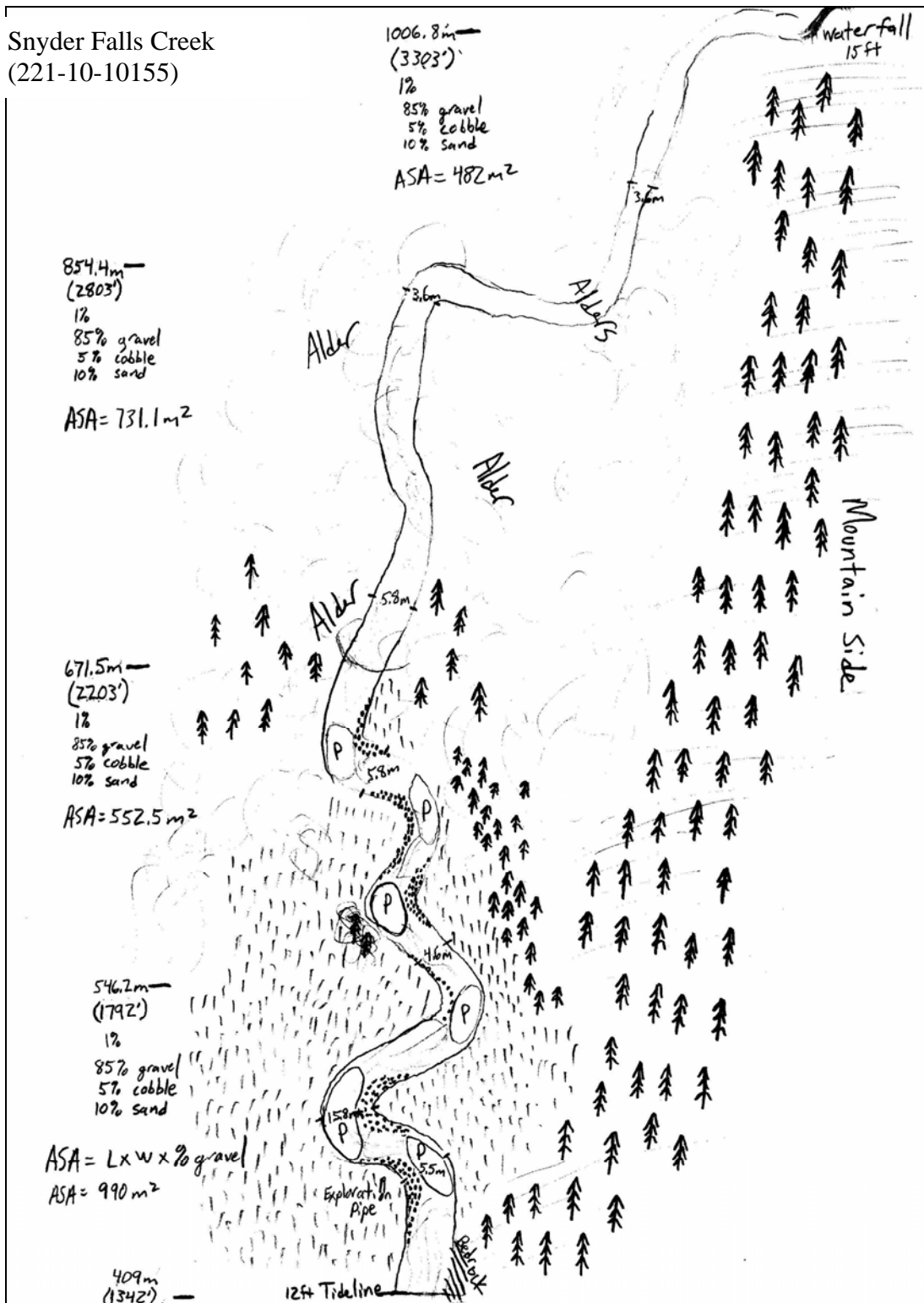
Photo C: Fish passage barrier, 300m from mouth.

Appendix A8.—Map of the unnamed stream 221-10-10155 with assorted woody debris, passage barriers, or other habitat related formations.



Appendix A8.—Page 2 of 2.

Snyder Falls Creek
(221-10-10155)



Appendix A9.—Photographs for (221-10-10155)
located on the eastern Rude River delta.



Photo A: Looking upstream 305m from mouth.



Photo B: Midsection of stream, 546m from mouth.



Photo C: Alder choked section of stream, 672m upstream from mouth.

Appendix A10.—Photographs of the Rude River
(221-10-10160) at the head of Nelson Bay.



Photo A: Mainstem of the Rude River from the confluence of the primary forks to the mouth.



Photo B: View of the east fork of the Rude River from the confluence of the east and north forks.



Photo C: View of the north fork of the Rude River.

Appendix A11.—Photographs of the unnamed stream number 221-10-10160-2011.



Photo A: Mouth of stream, confluence with Rude River.



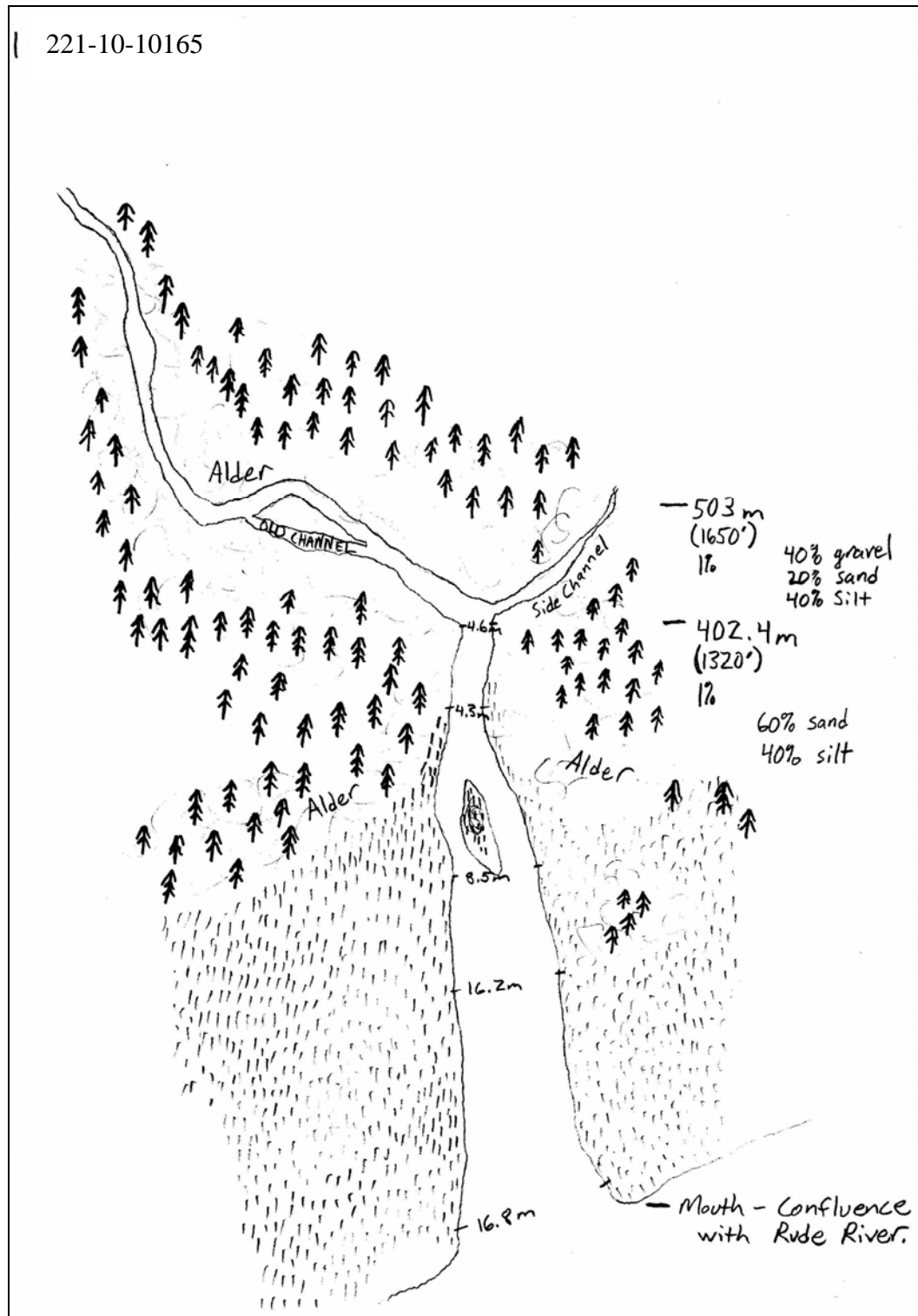
Photo B: Looking upstream midsection of stream.



Photo C: Upper section of stream.

Note: This tributary of the Rude River is located approximately 2.5 miles upstream from mouth.

Appendix A12.—Map of the unnamed stream 221-10-10165 with assorted woody debris, passage barriers, or other habitat related formations.



Appendix A13.—Photographs of the unnamed stream number 221-10-10165 located on the western Rude River delta.



Photo A: Stream mouth.

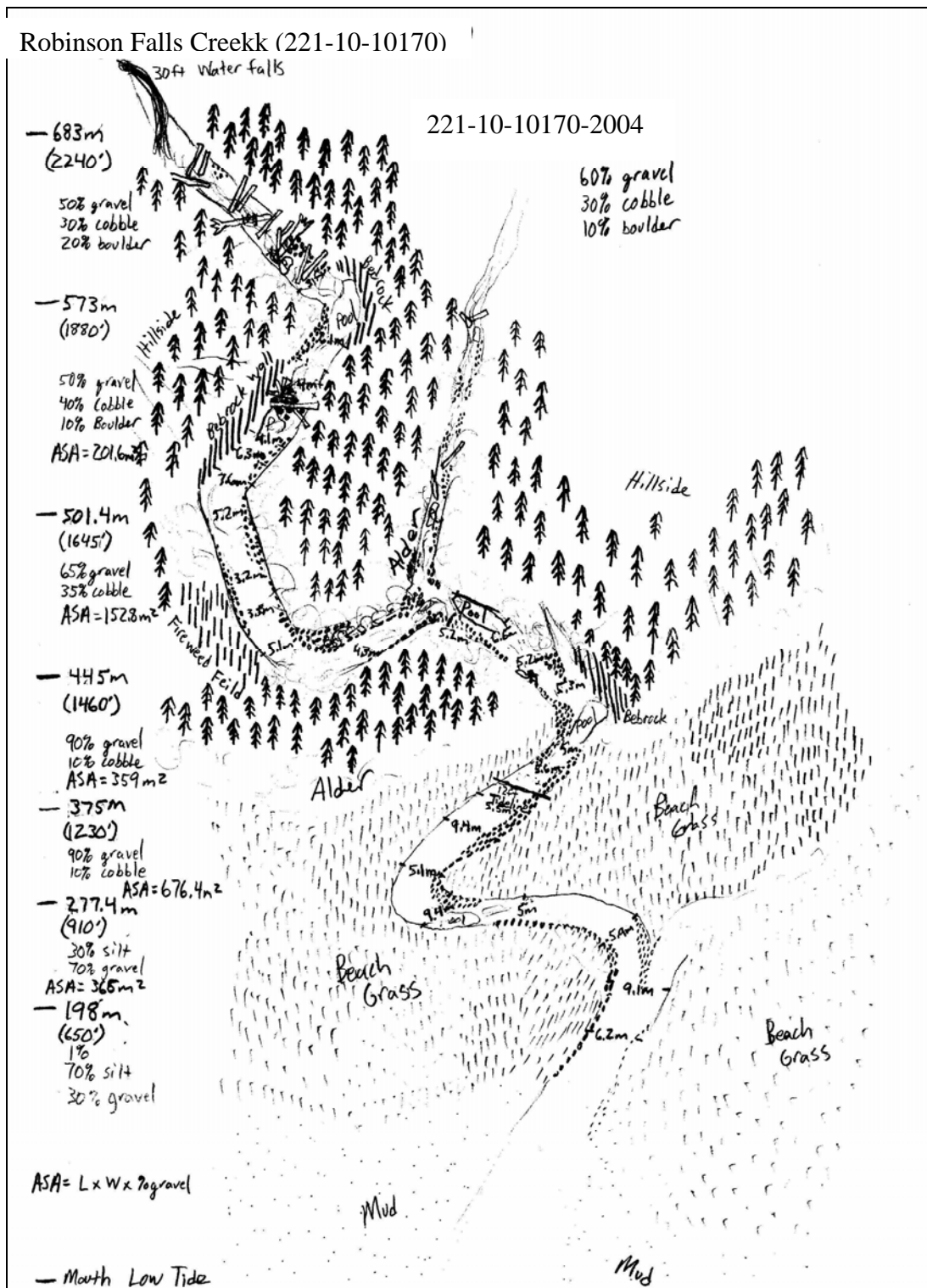


Photo B: Midsection of stream



Photo C: Upper section of stream.

Appendix A14.—Map of Robinson Falls Creek (221-10-10170) and 221-10-10170-2004 with assorted woody debris, passage barriers, or other habitat related formations.



Appendix A15.—Photographs of Robinson Falls Creek (221-10-10170) located in the northwest corner of Nelson Bay.



Photo A: Intertidal section 198m upstream from mouth.

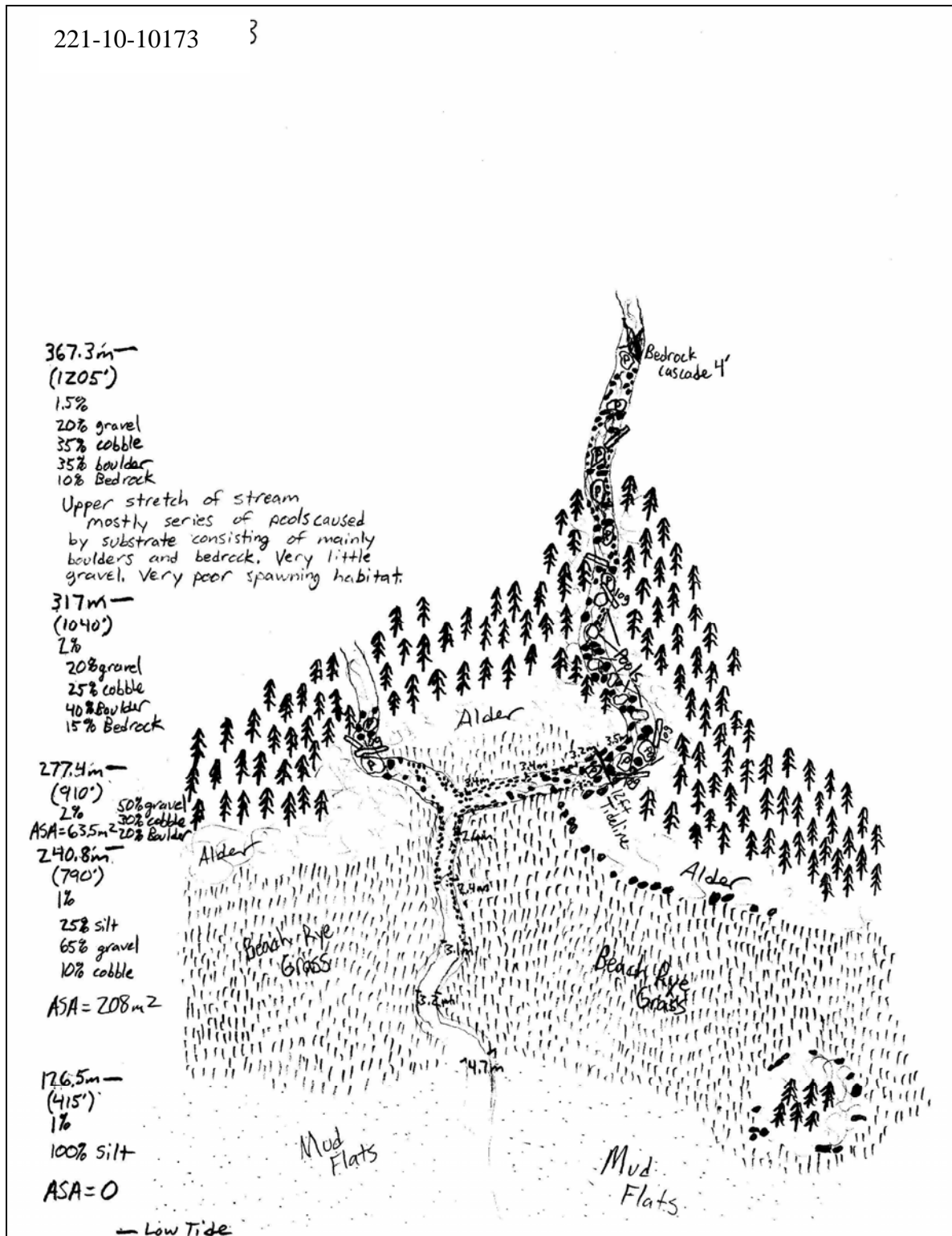


Photo B: Midsection of stream, 412m upstream from mouth.



Photo C: Upper section, 573m from mouth. Fish barrier in background.

Appendix A16.—Map of the unnamed stream 221-10-10173 with assorted woody debris, passage barriers, or other habitat related formations.



Appendix A17.—Photographs of the unnamed stream number 221-10-10173 located in northwestern Nelson Bay.



Photo A: High tide line looking downstream to mouth of stream.



Photo B: 275m from mouth looking downstream.



Photo C: Upper section of stream, 317m from mouth.

228-10-18640



Appendix A19.—Photographs of the unnamed stream number 228-10-18640 located on the north shore of Hawkins Island.

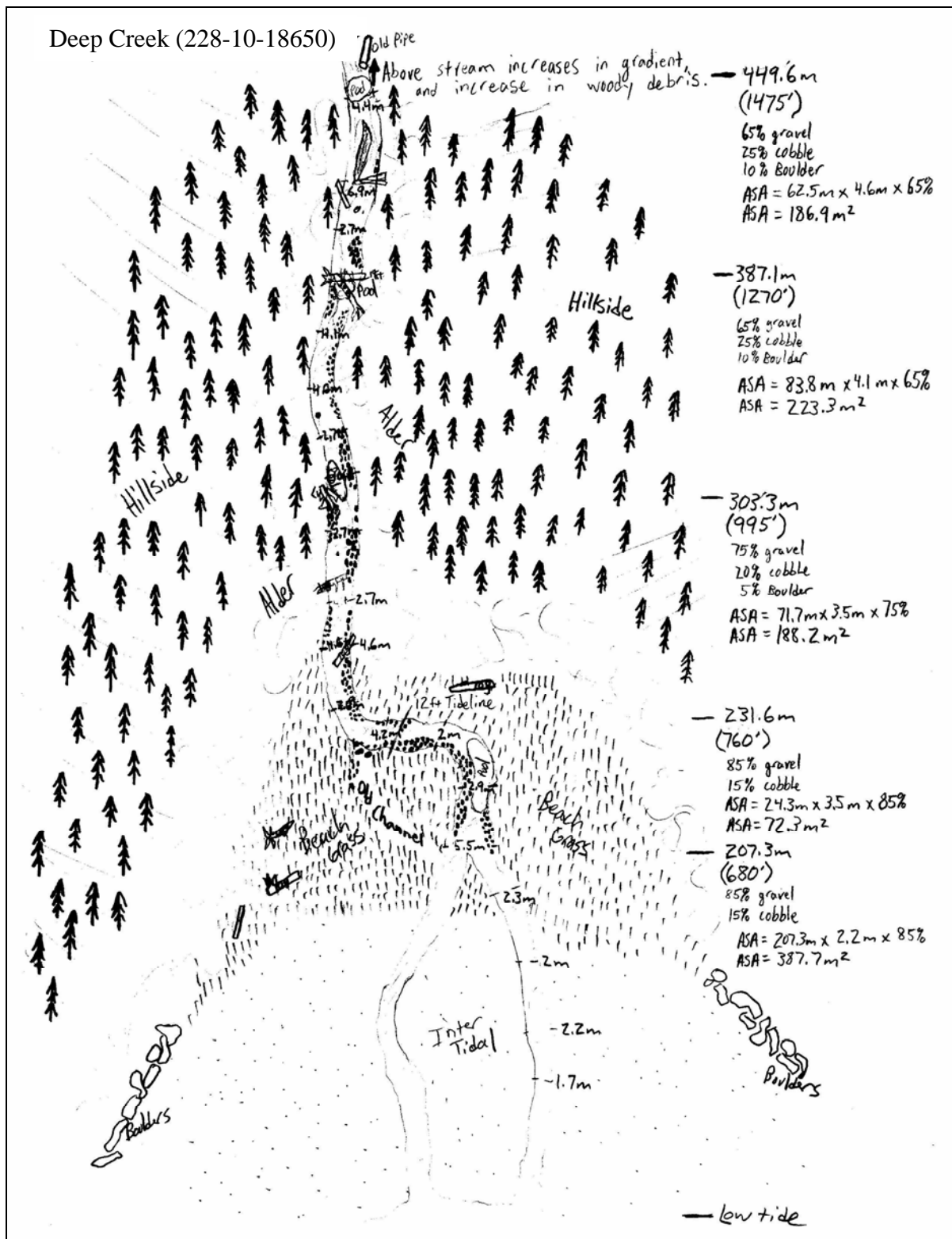


Photo A: Mouth of Stream



Photo B: High tide line looking upstream to fish barrier.

Appendix A20.—Map of Deep Creek (228-10-18650) with assorted woody debris, passage barriers, or other habitat related formations.



Appendix A21.—Photographs of Deep Creek (228-10-18650) in Deep Bay on the northeast side of Hawkins Island.



Photo A: Mouth of Stream

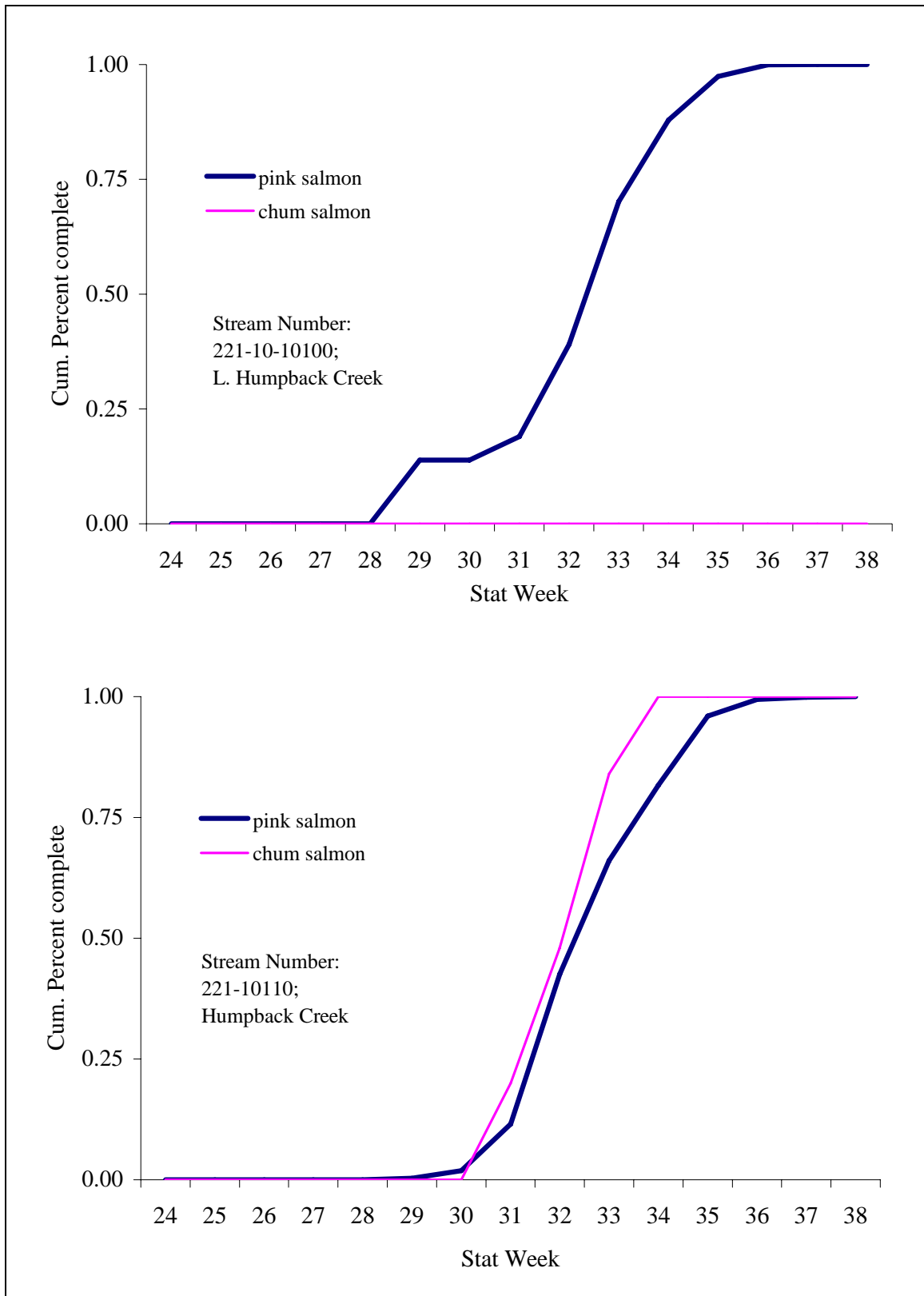


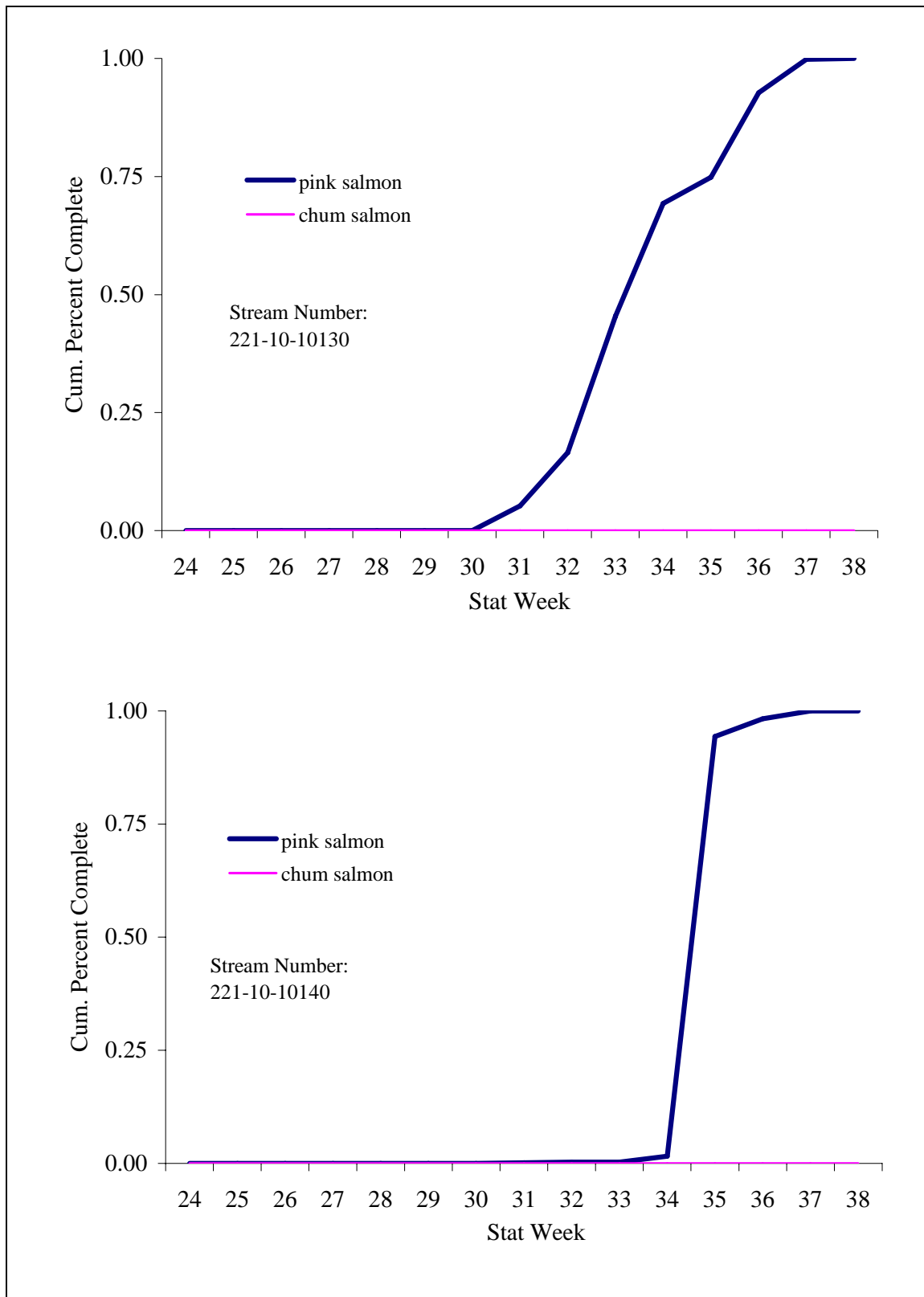
Photo B: Intertidal section of stream, 208m from mouth.

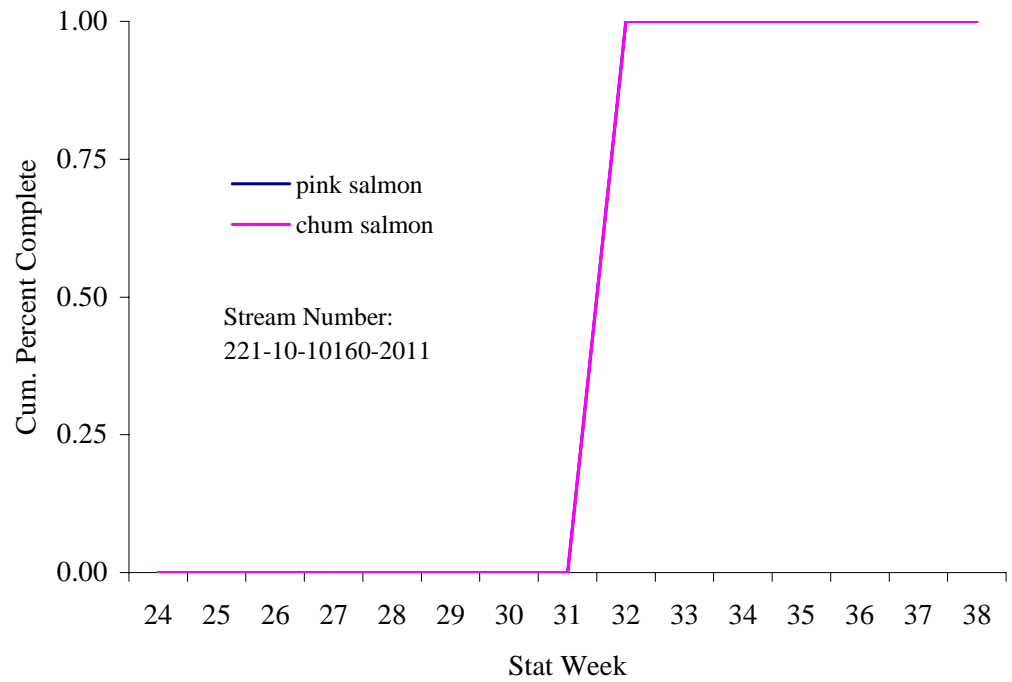
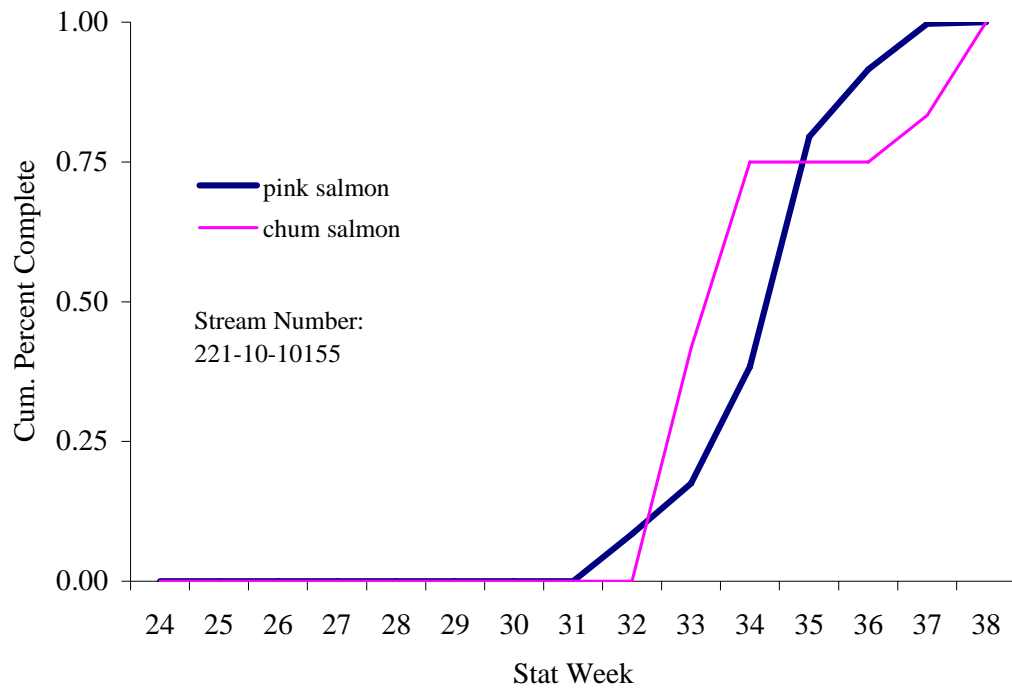


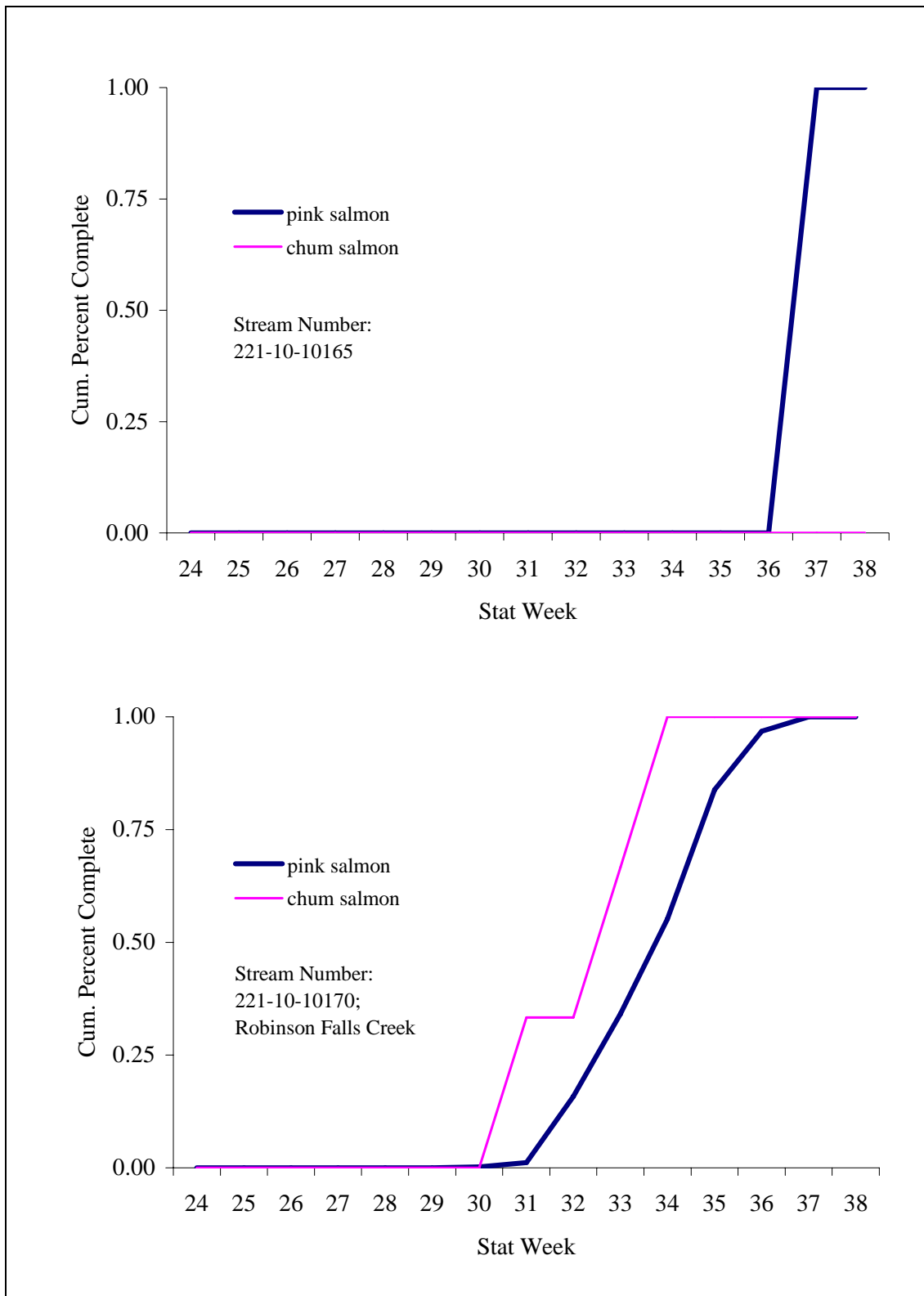
Photo C: Midsection of stream, 260m from mouth.

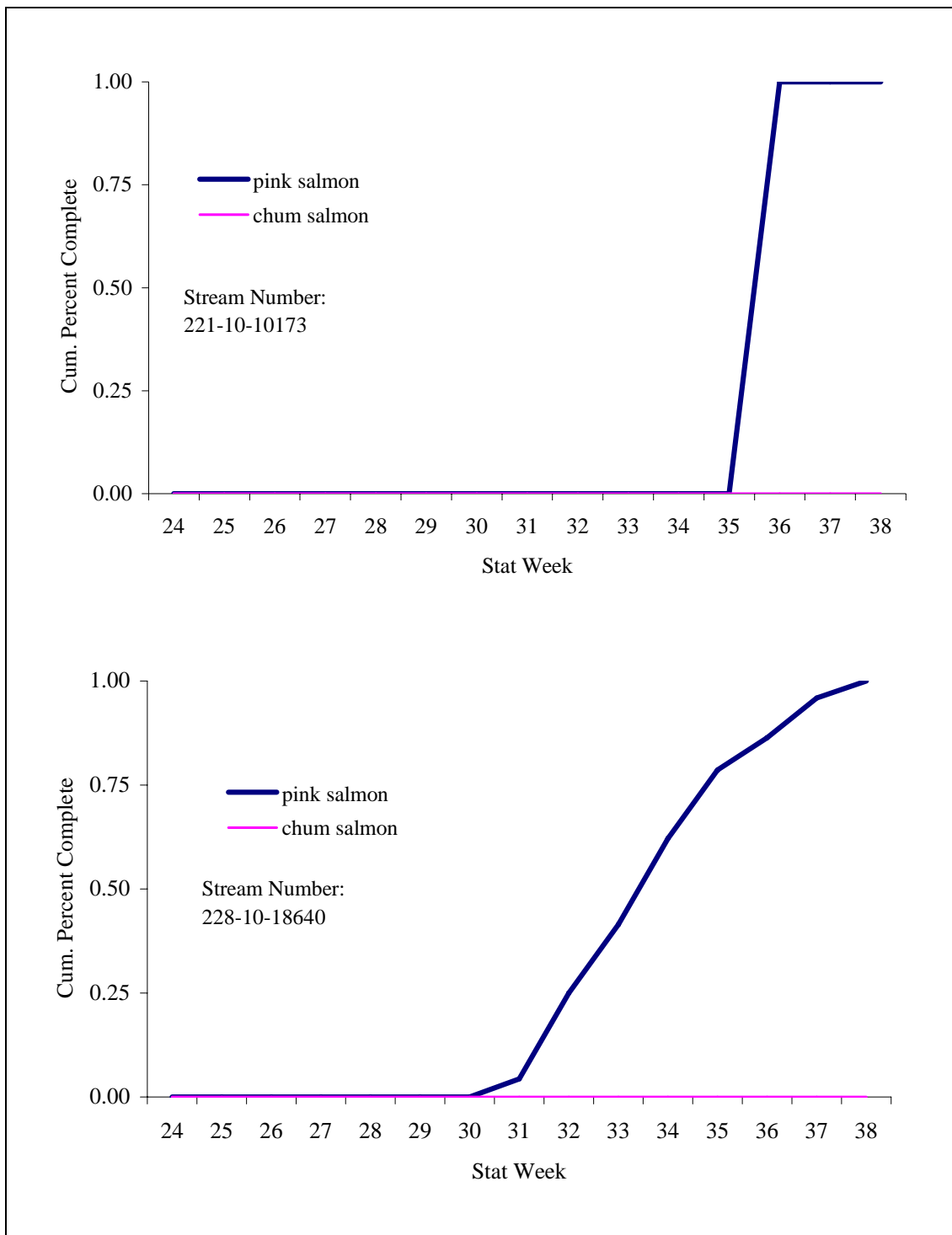
Appendix A22.—Observed escapement timing for pink and chum salmon by statistical week and stream number, 2004.

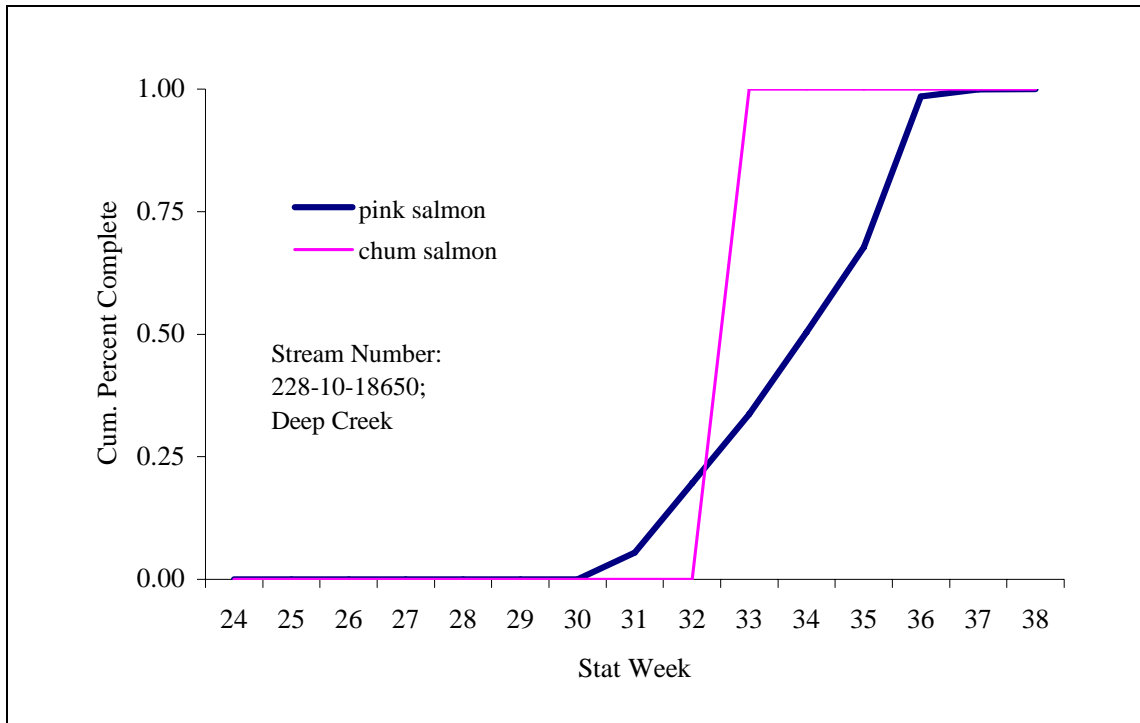






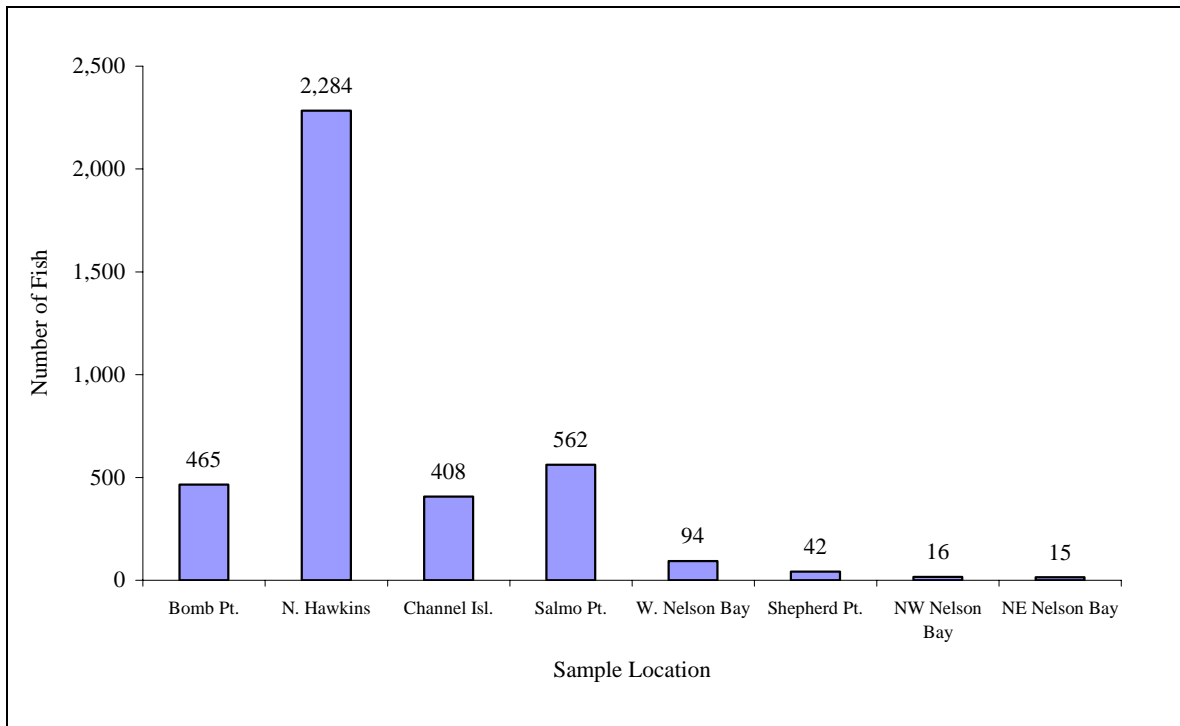




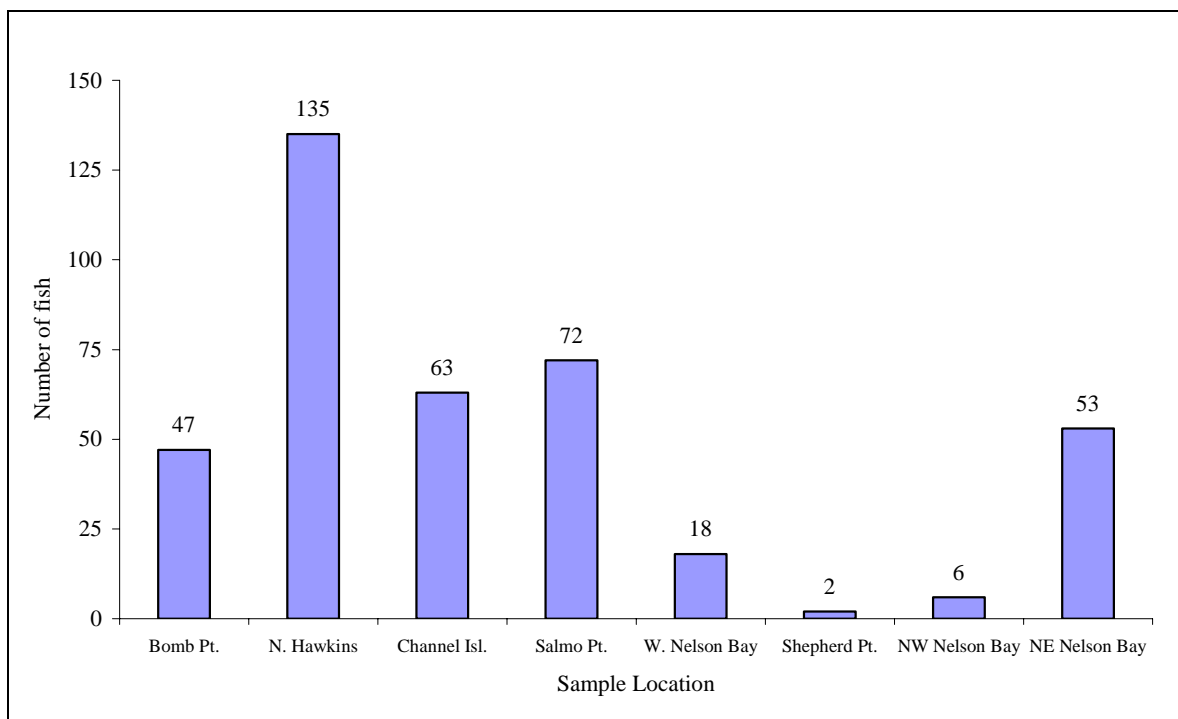


APPENDIX B. PURSE SEINE TEST FISHERY

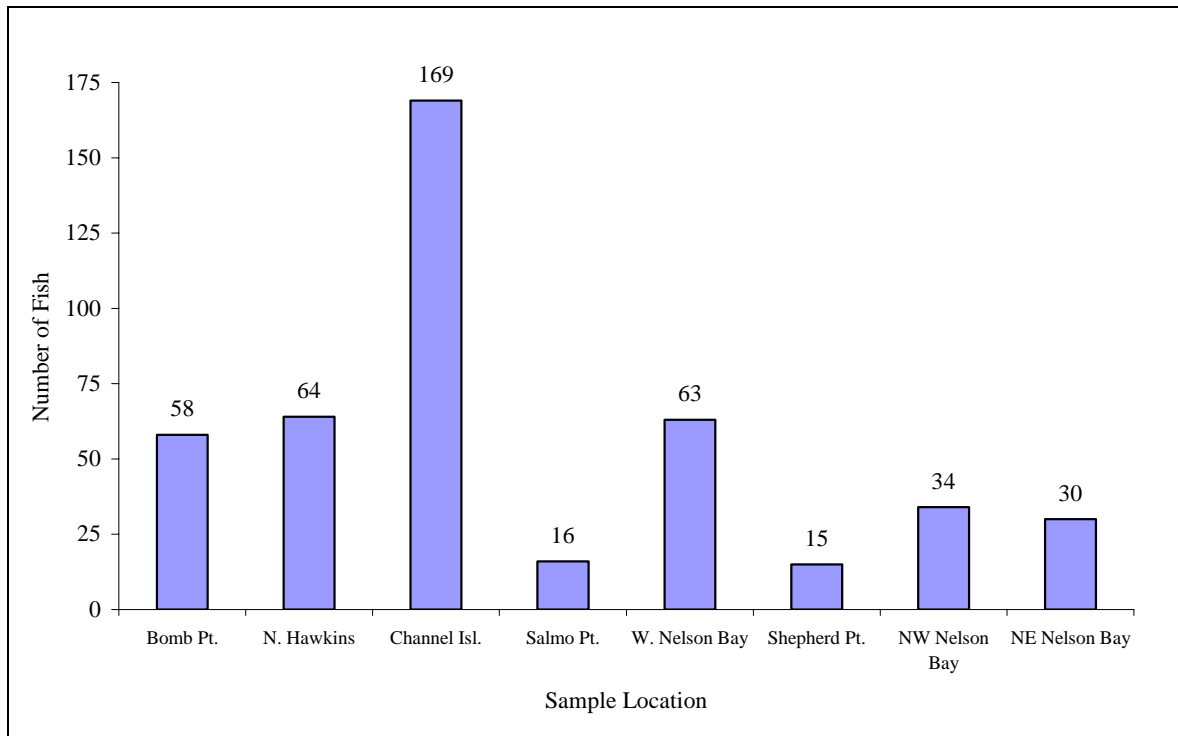
Appendix B1.—Total number of pink salmon caught by sample location from the Nelson Bay test fishery, 2004.



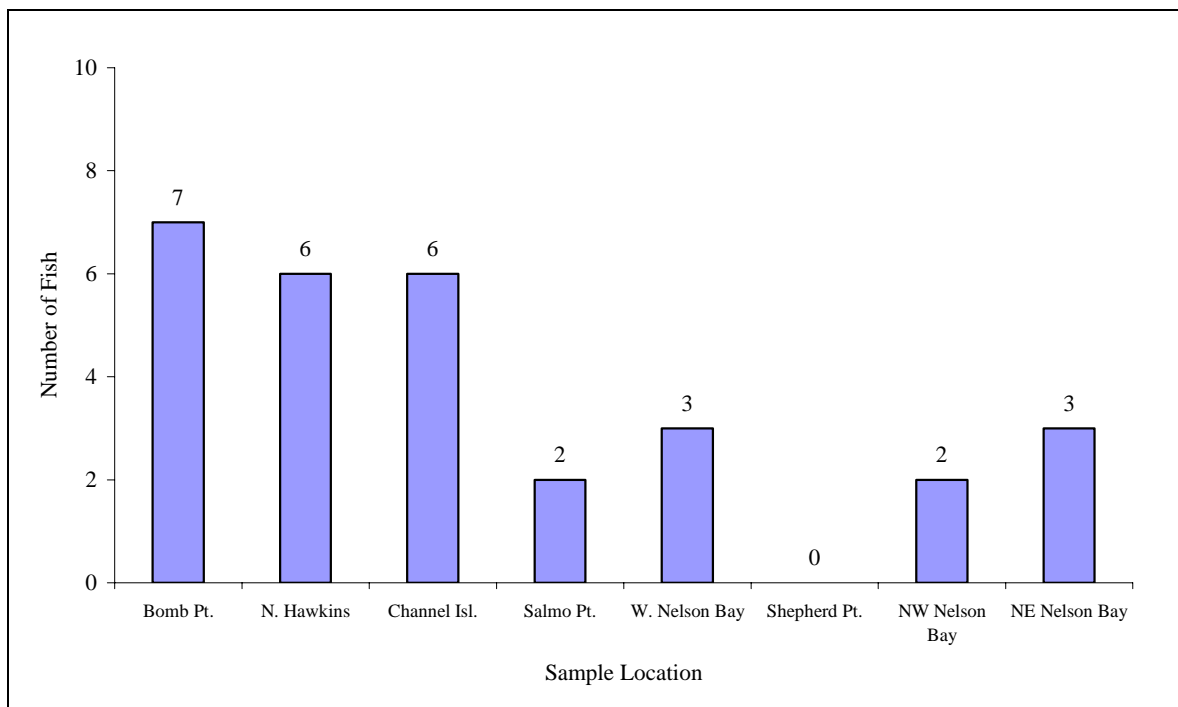
Appendix B2.—Total number of chum salmon caught by sample location from the Nelson Bay test fishery, 2004.



Appendix B3.—Total number of coho salmon caught by sample location from the Nelson Bay test fishery, 2004.



Appendix B4.—Total number of sockeye salmon caught by sample location from the Nelson Bay test fishery, 2004.



Appendix B5.—Cumulative catch timing of pink, chum, and coho salmon by statistical week and sample location, 2004.

